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Independent Review Panel Report for the 2016-2017 California WaterFix Aquatic Science Peer Review Phase 2a

A report to the Delta Science Program

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Scope and Purpose of the Review: This report presents the findings of the 2016 California WaterFix (CWF) Aquatic Science Peer Review Phase 2a. An Independent Review Panel (Panel; Appendix 1) was convened by the Delta Science Program to provide the National Marine Fisheries Service (NMFS), U.S. Fish and Wildlife Service (USFWS), and California Department of Fish and Wildlife (CDFW) to obtain the views of experts not involved in the CWF ESA consultation and 2081(b) permit on the use of best available scientific information as it pertains to analyses of effects on aquatic CESA-listed species in the California WaterFix Incidental Take Permit (CWF ITP) application. The agencies further requested review of the Adaptive Management Framework proposed to integrate future scientific research, monitoring, and decision making during construction and operations of CWF.

Accordingly, the Panel was charged specifically with reviewing: 1) the draft adaptive management framework for CWF and 2) the 2081(b) application analyses of the CWF impacts of take for Winter-run Chinook Salmon, Spring-run Chinook Salmon, Delta Smelt, and Longfin Smelt.

After reviewing the charge (Appendix 2) and a set of prescribed documents (0~~Appendix 3~~), the Panel participated in a public meeting in Sacramento, CA on December 8-9, 2016. On the first day of this meeting, the Panel interacted with agency representatives following their presentations on the topics above. On day 2, the Panel communicated and discussed its preliminary findings to agency representatives and the public (Appendix 4).

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Executive Summary

The new water conveyance facilities (North Delta diversion, NDD) proposed as part of the CA WaterFix project would create substantial changes in the aquatic environment of the lower San Joaquin and Sacramento rivers, a major portion of their estuary (Delta), and downstream in San Francisco Bay. The construction and operation of the WaterFix facilities must comply with ESA Section 7(a)(2) in addition to California Endangered Species Act (CESA) authorization under Fish and Game Code Section 2081(b). As part of the CWF ESA consultation, the US Bureau of Reclamation (Reclamation) and the CA Department of Water Resources (DWR) have written an extensive Biological Assessment (BA) that projects the future effects of the new facilities on ESA-listed species and their designated critical habitats.

The purpose of the California WaterFix (CWF) Aquatic Science Peer Review – Phase 2A is to provide the National Marine Fisheries Service (NMFS), U.S. Fish and Wildlife Service (USFWS), and California Department of Fish and Wildlife (CDFW) with an independent scientific evaluation of the Adaptive Management Framework used for the Endangered Species Act consultation. In addition, the Phase 2A review provides independent scientific peer review on the use of best available scientific information as it pertains to analyses of effects on aquatic CESA-listed species in the CDFW 2081 (b) Incidental Take Permit Application.

Adaptive Management (AM) Framework: The AM Framework represents a significant improvement in articulation of the action agencies' vision, including the four phase AM model, a section on structured decision-making, and a description of a new decision making entity, the Interagency Implementation and Coordination Group (IICG). , However, there are some details regarding plans for AMthat still need to be filled in. Key details to expand in the AM Framework are: (1) more details regarding the links between the AM Framework and real time operations including what safeguards and interventions belong in the real-time operational monitoring and the AM Framework will be responsible for; (2) a better portrayal and description of AM "triggers" in AM Framework-Appendix 1; (3)information and assurances regarding funding mechanism for both monitoring and research; (4) more details regarding how research priorities will be established through interactions between IICG and CSAMP/CAMT; (5) specific delegation of responsibilities among the entities that will oversee the AM program (i.e., IICG and Five Agencies); and, (6) plans for independent review.

Salmon: The effects analyses for salmon are comprehensive and objectively written in most (but not all) sections. Evaluation of impacts to salmon by life stage is important to help identify mechanisms and potential solutions but it is critical to evaluate cumulative impacts on ESU populations that propagate through the entire life history of salmon. Cumulative effects analyses, including interactive effects of the salmons' life at sea on spawning abundances, are critical for expressing what may be incrementally small effects within each life stage. Life cycle models can facilitate evaluation of cumulative impacts and one model (Interactive Object-oriented *Salmon* Simulation; IOS) indicated significant adverse impacts on salmon, especially during drier years. The large projected impacts from this model were not considered when evaluating Take and Jeopardy. Some models could be updated and re-run with newer data. An even more substantial issues is that survival analyses were based on tagging of large hatchery fall Chinook smolts that might bias survival patterns with respect to wild salmon, a significant portion of which are typically much smaller. Our concern is that water removal effects on survival of wild juvenile salmon may be underestimated by the current approach. Furthermore, the analyses likely underestimate potential effects of NDD operations on juvenile salmon habitat because they focus only dewatering of wetland bench habitat rather than other important aspects such as changes in salinity, access to rearing habitats, and other benefits of tidal wetland habitats throughout the Delta. More research is needed to adequately characterize migration chronologies and pathways, use of habitats and survival of smaller life history stages of salmonids in the Delta.

Longfin Smelt: Statistical and modeling of available data that compares PP vs. NAA maintenance of spring outflow equivalent to existing conditions indicate that averaging March through May is a cogent approach. However, the extensive uncertainty about the underlying mechanisms behind the Longfin Smelt abundance-Delta outflow relationship suggests that this averaging window may not necessarily reflect Longfin Smelt ecology and population viability. This could particularly be the case if diverse life history stages and metapopulations are not accounted for in this restricted three-month averaging window. Given this level of uncertainty, the Panel believes that the three-month averaging window should be contingent on and adjusted according to the results of the proposed, and hopefully high-priority Longfin Smelt research program under the Adaptive Management Framework (pg. 5-28, ICF 00408.12).

Delta Smelt: In the absence of parameterized life-cycle models, the methods used to characterize take and associated impacts to Delta Smelt populations were scientifically valid. With one major caveat, the beach seine surveys from the Delta Juvenile Fish Monitoring Program and Freeport diversion monitoring data are appropriate for assessing Delta Smelt habitat use near the NDD. The seines are deployed throughout the year, and the geographic range of deployment extends long distances both upstream and downstream of the NDD, using a reasonable number of stations. However, the beach seines are almost entirely deployed where there is minimal chance of snagging on subsurface obstructions. The result is that these monitoring data are likely representative of Delta Smelt occurrence along obstruction-free shorelines and at boat ramps, but are much less representative of more typical shoreline types across the Delta.

The effects of climate change on Delta Smelt did not consider climate conditions beyond 2039 due to perceived uncertainty in predictions beyond that point in time. Impacts related to future climate-related changes in X2 are based on 2025. Given that Delta Smelt are already near the NDD (as indicated by beach seines), and that most Delta Smelt habitat is downstream of the NDD, sea-level rise is expected to cause a larger proportion of the Delta Smelt population to be impacted by the NDD. Higher water temperatures are expected to cause comparable habitat compression and reduced reproductive potential under both the Proposed Project(PP) and No Action Alternative (NAA). Higher air temperatures are expected to shift precipitation away from snow and towards rainfall, changing seasonal and spatial snowmelt patterns, and thus altering the freshwater inflow patterns that affect Delta Smelt habitat availability and quality.

Delta Smelt population dynamics were not modeled due to widely recognized uncertainties in model parameterization. Year-to-year variation in individual effects (entrainment, X2, abiotic habitat index) was considered by water-year type. However, water-year type cannot represent monthly conditions because it is based on differently weighted flows during particular seasons plus the weighted index for the previous year. In reality, wet months can occur during dry years and vice versa. Given that the Delta Smelt is an annual species (i.e., each year class must survive continuously and then successfully reproduce), additional analyses should have been based on months that were independent of water-year type. It appears that averaging months within water-year classes diminished the numerical difference between the PA and NAA. Furthermore, as an annual species, Delta Smelt must successfully reproduce even during what are classified as "critical" water years by the water-year index. That is, survival to reproduction requires survival during all months and all years by every year-class of fish.

Even with the diminishment of apparent differences caused by averaging, there appears to be a meaningful difference in X2 between the PA and NAA, particularly during August and September, when X2 has a large likelihood of retreating into the river channels upstream of Chipps Island. Specifically, there appears to be a difference of several km within important river reaches that separate the river channels from critical shallow-water habitats downstream that are used as rearing habitat by early juveniles during August and September. Separation of X2 from critical shallow-water habitat in the vicinity of Suisun Marsh, Honker Bay, and Montezuma Slough is cause for concern.

Cumulative System Effects: The Panel recognizes that this 2081 (b) application is designed as species-level and life-stage-specific analyses, appropriate for maximal protection of CESA listed species. However, by taking this narrow approach, the analysis ignores that many of these species directly or indirectly interact over common Delta and Bay ecosystems and that their vulnerability to Proposed Project (PP) effects may be a function of cumulative effects of the project on physical and ecological processes across Delta ecosystems. The Panel suggests that cumulative, Delta-scale ecosystem effects of the PP need to be evaluated in the context of multiple overlapping and interacting populations of listed species and potentially significant competitor species and predator species (e.g., Striped Bass). Furthermore, collateral changes in potent interactions among the focus species and other (non-ESA) species' response should be assessed for significant competitor (e.g., invasive bivalves) and predator species (e.g., Striped Bass) that may benefit further from the PP changes to the Delta and eastern San Francisco Bay. Examples of cumulative or collateral, large-scale effects could include, but not be limited to, PP effects on: (1) tidal hydrology; (2) responses of mitigation actions, particularly tidal wetland restoration; (3) suspended sediment diversion; and, (4) interaction among targeted and other non-ESA species.

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1 Contents

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2 Introduction

2.1 Background

As part of its formal charge**,** the Panel was given the following Background for its review, which we quote in its entirety:

"*The California Department of Water Resources (DWR) and the Bureau of Reclamation (Reclamation) coordinate the operation of the Central Valley Project (CVP) and the State Water Project (SWP). As a part of California Water Fix (CWF), DWR proposes to construct and operate new water conveyance facilities in the Sacramento-San Joaquin River Delta, including three intakes, two tunnels, associated facilities, and a permanent head of Old River gate; as well as operate existing south Delta facilities in coordination with these new facilities.*

DWR intends to obtain California Endangered Species Act (CESA) authorization under Fish and Game Code Section 2081(b) for incidental take related to the construction and operation of the CWF and modified operations of the SWP. DWR submitted an Incidental Take Permit (ITP) application to California Department of Fish and Wildlife (CDFW) on October 5, 2016. This application includes analyses of the effects of the proposed action on CESA listed species. CDFW is reviewing the analyses of perceived impacts on state-listed species and may issue a permit if conditions in Fish and Game Code sections 2081(b) and (c) are met.

The construction and operation of the new dual conveyance facilities will need to comply with Section 7(a)(2) of the Endangered Species Act (ESA). As a part of the CWF ESA consultation, Reclamation and DWR have written a Biological Assessment (BA) that summarizes the effects of the action on ESA-listed species and their designated critical habitats. A Draft of the BA analyses and the draft analytical approach to the Biological Opinion were reviewed in Phase 1 of this review.

The analyses of CWF impacts of take for winter run Chinook, spring run Chinook, and Delta smelt in the 2081(b) application may be similar to what is expected as part of the Biological Opinions to be reviewed during Phase 2B. We expect that the Biological Opinion's *effects analyses for these species will be an additional, potentially more detailed source of analysis, supporting what is in the 2081(b) application.*

Current CVP/SWP operations require scientific research and monitoring to support real-time operations, decision making, and to fill in gaps in the understanding of the relationship between the CVP/ SWP operations and ESA and CESA listed fish species. Moving forward, adaptive management will be utilized to integrate real-time operations, ongoing scientific research, monitoring, and long term operations of CWF within the SWP and CVP.

The purpose of this independent scientific peer review is to obtain the views of experts not involved in the CWF ESA consultation and 2081(b) permit on the use of best available scientific information as it pertains to analyses of effects on aquatic CESA-listed species in the CWF ITP application and the Adaptive Management Framework proposed to integrate future scientific research, monitoring, and decision making during construction and operations of CWF."

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End of Quote

2.2 Charge to the Panel, with Summary Panel Responses

In this section, we summarize the Charge to the Panel (Appendix 2) and provide a brief Panel response, in italics, to each of the specific Charge items. Details of Panel responses are provided in Chapter 2.

2.2.1 CWF Adaptive Management Framework questions

Are the compliance monitoring, collaborative science, and adaptive management approaches in the Framework appropriate for addressing the uncertainties associated with the implementation of CWF, specifically related to CWF operations in conjunction with SWP and CVP facilities?

In addressing the following questions about the Adaptive Management Framework, we preface our comments with the Panel's interpretation of the overarching purpose of the AM Framework, which is to contribute to the task of complying with federal and state laws regarding threatened and endangered species in the context of a great deal of uncertainty about the PA's impacts. The AM Framework should therefore be thought of as an add-on "insurance policy" for ESA-listed species if the PA goes forward. It should be precautionary and proactive to protect against uncertainties, including the effects of climate change that may affect smelt, salmon, Steelhead, Green Sturgeon, Killer Whale, and their critical habitats.

This framework should be nimble enough to facilitate intervention if new information suggests a need for change and it should be governed such that politics do not prevent action when needed. The Framework should (1) create a clear and strong mechanism for adjusting operations or reinitiating consultation if monitoring reveals unexpected effects and/or exceedance of permitted take; and (2) set priorities for research and monitoring in an unbiased way that will reduce relevant uncertainties about the species' needs and improve the effectiveness of mitigation measures. The Panel is particularly interested in the concept that the AM Framework might serve as the authoritative "umbrella" for systematic assessment of restoration and improve the effectiveness of mitigation planning and implementation., e.g., at least hydrodynamic modeling, of the CWF measures.

In brief, the Panel suggests that compliance monitoring[1] could be improved and tied to triggers that will initiate change when monitoring indicates noncompliance. The collaborative science aspect of the AM Framework is strong, in that there are connections with CSAMP/CAMT and other science endeavors, but there are some concerns about the makeup of the IICG, in that it seems to include some but not all stakeholders. The AM approaches in the framework are in line with best practices for adaptive

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[1] We are considering "compliance monitoring" to be equivalent to "effectiveness" monitoring.

management; but there are some concerns about decision making authority regarding implementing change and determining scientific priorities.

Question 1A: Does the Framework adequately reflect comments and issues raised in Phase 1 of this review?

The AM Framework addresses many of the comments and issues raised in the Phase 1 Review, namely the need for a description of how research, monitoring and decision making will be organized and carried out, but more details are still needed. Although the Panel is aware that current and future CVP and SWP operations will fall under existing RPA, BOs and other legal venues, we are still unsure what actions are associated with future real-time operational monitoring and what belongs in the AM Framework under the new CWF facilities. The Panel would like to see (1) more clarification of the relationship between adaptive management and real time operations including details about what safeguards and interventions belong in the real-time operational monitoring and what belongs in the AM Framework; (2) a better portrayal and description of AM "triggers" in AM Framework-Appendix 1; (3) information and assurances regarding funding mechanism for both monitoring and research; (4) more details regarding how research priorities will be established; (5) specific delegation of responsibilities among the entities that will oversee the AM program (i.e. IICG, Five Agencies, CSAMP/CAMT) and (6) plans for independent review.

Question 1B: Is the Framework sufficient to address the uncertainties associated with the current analyses and provide a timely mechanism for addressing future changes in operations based on new understanding of listed species distribution and abundance?

The Framework is a good start, assuming the scientific questions will be appropriately prioritized and actionable metrics will be developed to help avoid jeopardy and promote restoration and recovery. The Framework includes a representative list of uncertainties and potential research topics but it is unclear how and which uncertainties will be targeted for reduction through experimentation and learning, and how the IICG will coordinate with CSAMP/CAMT to make those determinations. In terms of a "timely mechanism" for addressing needed changes in operations, it is unclear whether there will be an AM mechanism for responding to unanticipated events on a timescale of less than 1-2 years, e.g., from results indicating the need to adjust to new plans for real-time operations.

Question 1C: How well does the Framework build off and incorporate existing adaptive management or related efforts? Does the Framework adequately address areas or gaps not currently covered by existing efforts?

The Framework builds on several other initiatives (IEP-MAST/SAIL/CSAMP/CAMT) toward developing an adaptive management process and management relevant science that incorporates the most notable research. However, the major task presently unaddressed will be how the wide array of potential *research and monitoring activities will be prioritized even further and readily implemented in active and passive adaptive management actions.*

Question 1D: How thoroughly do the steps and decision making processes outlined in the Framework support its intent and objectives?

The four phases of adaptive management are well described and are in alignment with the core principles of adaptive management. Assuming the "intent and objectives" of the Framework are to assist with Section 7 compliance (i.e., protect the fish), then the decision-making processes regarding what research and monitoring gets funded and carried out should be primarily based on best available science. While we support the inclusion of stakeholders in the implementation of AM in the Delta, the Panel is concerned about stakeholders' influence on the research prioritization since decisions associated with Phase 4 ("Adapt") have possible impacts or benefits on certain stakeholders. The Panel is also concerned about links between possible sources of funding for the AM program and decision making authority regarding what science is prioritized. More attention needs to be paid to setting up an adaptive governance structure with clearly defined authority, boundaries, and criteria for intervention to support a robust and effective AM program (e.g., conflict of interest) akin to the two-tiered program structure of CSAMP/CAMT, with a scientific/technical committee and a separate management/policy committee. Also, if stakeholders are going to be involved in decision making regarding research, then the Agencies must ensure that all stakeholders are represented, not just the water users, as currently envisioned in the IICG.

Question 1E: Do the commitments to new research, monitoring, and modeling appropriately support the management component of the Framework?

The Framework describes commitments to new research, monitoring and modeling, but details are lacking regarding guarantees behind the commitments. How will the Agencies address the need for additional resources, people, and capacity for research? The Panel notes the inclusion of a section on Funding, but details are still missing, which makes evaluation of adequacy and effectiveness difficult.

Question 1F: Will the approaches to scientific research and monitoring allow robust and adequate documentation of effectiveness in reducing uncertainty associated with CWF and existing measures to minimize and mitigate impacts to species?

The Framework provides good information regarding plans for research and monitoring, however, the Agencies need to explain how they will determine effectiveness in reducing uncertainty. What are the criteria for effectiveness?

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Question 1G: Will the approaches to scientific research, monitoring, and associated decision making allow for tracking the effects of CWF on populations of the four listed species over time and the effectiveness of management actions?

The CWF BA did not describe future studies and monitoring efforts, the designs of which have not been finalized. Detection of future changes in listed species' distribution and abundance will be dependent on these unknown details.

Monitoring needs to be designed with the capability to assess the outcomes of adaptive management and mitigation actions and their implications for the survival and recovery of ESA-listed species. The criteria for determining "effectiveness of management actions" needs to be explicitly described. While tracking the effects of CWF and associated management actions in an effective manner is certainly critical, the Panel's bigger concern around decision making concerns transparency and accountability regarding how decisions will be made in response to what is tracked.

2.2.2 CDWF 2081(b): general permit questions

The CWP ITP report only addresses species that are listed under the California ESA. Therefore, Panel responses to the CWF ITP questions below do not address PA effects on federal ESA-listed Steelhead, Green Sturgeon, and Killer Whale.

To what extent are the analyses used for the CDFW 2081(b) permit application scientifically sound and their conclusions scientifically supported?

The application recognizes where uncertainty limits the type of analyses that can be defended. For those analyses that can be defended, the methods are generally sound and are scientifically supported. In general, the best available science has been used but we recognize that new information and analyses are still required to effectively evaluate the impact of the project. Conclusions regarding the overall effects of the PP on salmon did not consider cumulative impacts identified in some analyses and did not fully evaluate potential impacts of CWF operations on salmonid habitats across the Delta.

Question 2A: Do analyses of CWF operations and impacts to species through 2060 resolve panel comments raised in Phase 1 of this review? Is climate change adequately incorporated into the cumulative analysis?

For Delta Smelt, thermal effects depend on results published by Brown et al. (2016), but the application did not consider climate effects beyond 2039 due to uncertainty in future trends in greenhouse-gas emissions. Two, widely divergent emission scenarios were applied by Brown et al. (2016) predictions that extended to the year 2100. The panel assumes that the application did not consider climate effects *beyond 2039 due to mid-century divergence in the two emission scenarios that were evaluated by Brown et al. (2016). Impacts related to future climate-related changes in X2 are based on 2025. It is acknowledged that entrainment at the NDD may increase due to increasing sea level. Higher water temperatures are expected to cause habitat compression and reduced reproductive potential under both the PP and NAA to comparable extents. Higher air temperatures are expected to shift precipitation away from snow and towards rainfall, changing seasonal and spatial snowmelt patterns and thus Delta inflow (Section 5.A.A.2, Appendix 5.A- Attachment 2). These positions are incorporated into the cumulative effects.*

Quantitative analyses involving salmon only considered climate effects through 2030. The CWF ITP should justify why it concluded that climate change will not differentially impact salmon via the PP versus NAA, especially considering anticipated trends beyond 2030. An adverse effect of the PP on Chinook Salmon viability in the future when overall conditions are less favorable may have greater consequences than at present.

Question 2B: The 2081(b) application currently utilized long-term averages to analyze near and far field effects of CWF operations on habitat conditions. Does this approach adequately describe year-to-year effects of CWF on covered fish species' population dynamics? Are there alternative analytical approaches available that are more appropriate?

Delta Smelt population dynamics were not modeled due to widely recognized uncertainties in model parameterization. Year-to-year variation in individual effects (entrainment, X2, abiotic habitat index) were considered by water-year type. However, water-year type cannot represent monthly conditions because it is based on differently weighted flows during particular seasons plus the weighted index for the previous year. Dry months can occur during wet years and wet months can occur during dry years. Given that the Delta Smelt is an annual species (i.e., each year class must survive continuously and then successfully reproduce), additional analyses should have been based on months that were independent of water-year type. It appears that averaging months within water-year classes diminished the numerical difference between the PA and NAA.

<more added to this section later>

Question 2C—Part A: Is the approach used to characterize take and associated impacts to covered fish species populations scientifically valid given current understanding and the recognized limitations of available tools?

<section in development>

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Question 2C—Part B: Are there improvements to the current methods that could be implemented, or are there available alternative analytical approaches that are more appropriate for analyzing the extent of take and associated impacts to the species?

<section in development>

Question 2D: Do the conclusions of the effects analyses for covered species adequately acknowledge and incorporate uncertainty as recommended in Phase 1 of this review?

<section in development>

2.2.3 CDWF 2081(b): Longfin Smelt questions

Question 3A, 3B: (3A) Is the proposed approach to achieve the March through May spring outflow targets for Longfin Smelt likely to result in spring outflow equivalent to existing conditions? (3B) The relationship between outflow and Longfin Smelt abundance uses a six-month (January through June) averaging window (Kimmerer 2009). How well does the 2081 (b) application justify using a three month (March through May) averaging window to provide outflow targets and operational criteria during that period?

Based on the available statistical and modeling results of PP vs. NAA for maintaining spring outflow equivalent to existing conditions, averaging March through May is logical. However, given the extensive uncertainties about Longfin Smelt population viability and the underlying mechanisms behind the Longfin Smelt abundance-Delta outflow relationship, the three-month averaging window should be explicitly dependent on and adjusted according to the results of the proposed, and hopefully high-priority Longfin Smelt research program under the Adaptive Management Framework (pg. 5-28, ICF 00408.12).

2.2.4 CDWF 2081(b): Delta Smelt questions

Question 4A: In the analysis of CWF construction and operational effects, how appropriate are beach seine surveys from the Delta Juvenile Fish Monitoring Program and Freeport diversion monitoring data (ICF 2015), in which Delta Smelt have been observed as by-catch, to characterize the proportion of the total Delta Smelt population in the vicinity of the north Delta diversions? Could these datasets be analyzed differently to better support the effects analysis?

Yes, the net and deployment specifications are appropriate. The nets are deployed throughout the year and the geographic range of deployment extends long distances upstream and downstream of the NDD, using a reasonable number of stations. Perhaps as a high-priority research initiative under the

Adaptive Management Framework, the agencies should seriously examine the representation of the beach seine monitoring sites in evaluating the more systemic effects of the CWF.

2.2.5 CDWF 2081(b): Chinook Salmon questions

Question 5A: How well does the effects analysis evaluate new adverse effects on salmonid species due to north Delta operations and changes in south Delta operations?

<section under development>

Question 5B: Are the analyses of take by life stage and water year type scientifically sound? How useful are these analyses for determining annual population impacts?

<section under development>

3 Expanded Question-Specific Comments from the Panel

This section contains detailed comments on questions summarized in Section 1, above.

3.1.1 Positive Feedback

<section under development>

3.1.2 CWF Adaptive Management Framework questions

The Adaptive Management Framework included in the California WaterFix Proposed Action (PA) is an important component in the Five Agencies' approach to complying with state and federal endangered species legislation. Without its provisions for adjusting management in response to new information about the listed species' needs, there would be no guarantee that uncertainties will be reduced over time in a systematic manner. Even though the AM Framework cannot guarantee future actions, the Panel suggests that it can be usefully thought of as an "insurance policy" for the fish.

We suggest that this warrants a specialized approach to AM that may differ in significant ways from AM practiced in contexts where it is not part of a Biological Opinion. While the AM envisioned in the Draft BO will likely benefit a broad cross section of conservation interests in the Bay Delta, its primary purpose will be narrower – to help ensure, on an ongoing and long-term basis, that listed species are not jeopardized by the PA (in conjunction with the SWP/CVP) and that critical habitat is not adversely modified by the PA. It must also help ensure that conservation actions in the PA are achieving their intended purposes. As such, there would seem to be a higher duty to respond to results of monitoring than there might be in other contexts, and a higher duty to err on the side of the species when there is uncertainty about results (i.e., the precautionary principle). Due to the nature of this link between AM and Section 7, attention to the difference between active and passive AM in the BO, and a commitment to practicing active AM where possible, will be critical.

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The AM Framework should be precautionary and proactive to protect against uncertainties related to the effects of the PA, including the effects of climate change that may affect smelt, salmon, steelhead, sturgeon, killer whale and their habitat. It should also provide clear guidance for setting priorities for science that will reduce uncertainty about the species' needs along with assurances that the research and monitoring will be funded and carried out.

It is worth noting that in a review of adaptive management and the law, Benson and Schultz (2015, 41) observe that without adequate legal grounding, AM provides agencies with an undesirable amount of discretion. Citing Schultz and Nie (2012), they warn that

> "Unless adaptive management is given some legal definition and its application is enforceable in some way, the approach can be used as a smokescreen for open-ended and discretionary decision making that fails to meet legal standards, lacks accountability, and fails to incorporate some of the most important aspects of the paradigm, including rigorous monitoring and feedback loops that *inform an adaptive planning cycle.*"

Adaptive Management plans associated with Section 7 of the ESA should: (1) clearly articulate measurable goals and quantitative objectives; (2) identify testable hypotheses (or some other method of structured learning from conceptual models); (3) state exactly what criteria should apply in evaluating the management experiments; and (4) be explicit about how the results from AM research and monitoring are to be tied to operational or project-based changes (Ruhl and Fischman 2010, Stern et al 2011).

It is with these general principles and standards in mind that we evaluate the AM Framework associated with the CWF PA in our answers below.

Are the compliance monitoring, collaborative science, and adaptive management approaches in the Framework appropriate for addressing the uncertainties associated with the implementation of CWF, specifically related to CWF operations in conjunction with SWP and CVP facilities?

This overarching question has a number of components but focuses on the degree to which the AM Framework addresses and attempts to reduce uncertainty. Given that the key uncertainties associated with the implementation of CWF have to do with whether it will likely jeopardize ESA-listed species and/or adversely modify listed species' critical habitat, we suggest the following rewording to enable a clearer response: *Does the AM Framework appropriately address and seek to reduce the uncertainties about (1) whether the CWF (in conjunction with SWP/CVP) will likely jeopardize fish and/or adversely modify critical habitat and (2) whether the plans to minimize and mitigate impact will be adequate to avoid jeopardy and adverse modification of critical habitat?* We answer this question by focusing on the three key aspects of the Framework highlighted in the original question: Compliance Monitoring, Collaborative Science, and the overall approach to adaptive management, which we interpret to refer to Governance and Decision-making.

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Compliance Monitoring

In this section, we consider whether future monitoring will be sufficient to detect jeopardy and/or adverse modification of critical habitat associated with the project facilities, such that the PA remains in compliance with Section 7. As part of this, consideration should be given to whether monitoring of activities permitted under the Incidental Take Permit is adequate to detect excessive take. Consideration should also be given to whether future monitoring will be sufficient for determining whether conservation measures are working to reduce jeopardy and/or adverse modification of critical habitat.

We begin with a review of literature and case law related to the role and design of monitoring strategies in AM frameworks associated with Section 7 compliance, then evaluate the proposed AM Framework in light of recommended principles and features.

Court cases related to the use of AM in Section 7 Biological Opinions have focused on the adequacy of monitoring and mitigation strategies in AM frameworks. In an oft-cited 2002 case, the court explained that "mitigation measures must be reasonably specific, certain to occur, and capable of implementation; they must be subject to deadlines or otherwise-enforceable obligations; and most important, they must address the threats to the species in a way that satisfies the jeopardy and adverse modification standards" (*Center for Biological Diversity v. Rumsfeld* 2002).

As cited in our Phase 1 review, AM frameworks designed by FWS and NMFS for operation of the CVP/SWP were viewed differently by the same judge in 2007 and 2008. The AM framework designed by FWS for the Delta Smelt was seen as inadequate, while the AM framework designed by NMFS for the anadromous fish species was upheld. The difference had to do with the degree of enforceability associated with monitoring and mitigation.

In the FWS AM plan, management changes would be triggered based on factors such as estimates of number of fish killed in water facilities and spawning rates. If thresholds were crossed, a working group could meet and submit recommendations that could potentially be undertaken by a separate management team. The court found this too uncertain and unenforceable to support a No Jeopardy opinion.

In contrast, the court determined that mitigation measures in the NMFS AM plan were adequately specific, since they required action if a certain water temperature was exceeded, and were included under "Terms and Conditions" of the Incidental Take Statement, which is enforceable by law and therefore binding.

The key point is that monitoring and mitigation commitments made as part of an AM framework must be based on enforceable standards, which trigger a non-discretionary mandate to reinitiate consultation with the regulatory agency before proceeding in order to survive a legal challenge.

> "Generally speaking, in order to be enforceable, a plan must include specific monitoring requirements and timelines tied *to* the use of explicit trigger points, to clear mitigation requirements, along with specific implementation timelines. When such a monitoring/mitigation

> program is part of a legally binding agreement, such as in the case of a permit issued under the ESA, enforcement is more possible, especially where monitoring serves as a precondition for renewal." (Benson and Schultz 2015, 55).

As Benson and Schulz (2015, 55) observe, "enforceability within the parameters of administrative law is a significant challenge and one that requires concerted attention to the details of the adaptive management strategy and the legal context within which commitments are made."

Compliance Monitoring in the AM Framework is discussed on pages…. …. One example of compliance or effectiveness monitoring planned is of salmon survival through the NDD reach, and evaluation of the non-physical barrier at Georgiana Slough. The latter is very important.

Overall, the Panel's impression is that monitoring needs to be updated and improved and tied to triggers that will initiate change when monitoring indicates noncompliance.

The Panel looks forward to seeing more details about compliance monitoring in the BiOp.

Collaborative Science

In this section, we consider whether the planned science is set up to be able to reduce uncertainty and answer questions about: (1) whether the project is likely to cause jeopardy and/or adverse modification of critical habitat; and, (2) whether the conservation measures are working to reduce the likelihood of jeopardy and/or adverse modification of critical habitat.

According to the Framework, the Science Plan will be developed collaboratively using the CSAMP/CAMT process, and the science will undergo independent review coordinated by the Delta Science Program.

The Framework reflects best practices for collaborative science in many places and articulates a plan to integrate with other ongoing AM efforts in the Delta including CSAMP/CAMT and IEP. We comment on this further under Question 1C, below.

Where the Framework appears to depart from the collaborative model envisioned is in the design of the IICG, which will play an important role in the implementation of the AM program. Water users participate in science planning, but stakeholders representing other interest groups are not represented. We comment on this more below, and under Question 1D.

Adaptive Management Approach: Governance and Decision Making

In this section, we consider whether the AM program is set up to be able to respond to signals that (1) the project is likely to cause jeopardy and/or adverse modification of critical habitat and (2) the conservation measures are not working to reduce the likelihood of jeopardy and/or adverse modification of critical habitat.

In order for adaptive management to be successful, it needs to be embedded in an adaptive governance structure. The Agencies responsible for Section 7 compliance must recognize that AM occurs in "contested and power-laden social contexts" and that the approach to decision making (and the allocation of power) will influence how trade-offs between multiple, competing objectives are made (Armitage et al. 2015, 241). While best available science should be the primary guide in decision making to ensure compliance with Section 7, it will be important to supplement scientific knowledge with other sources of information from diverse sources to ensure legitimacy and accountability. One of the key challenges in adaptive governance is how to best incorporate non-agency interests into the deliberations.

Literature on adaptive governance supports the two committee approach with the typical arrangement being a technical committee with scientists and practitioners (similar to CAMT) and a management committee with oversight authority that includes citizens, NGOs and other interest groups (similar to CSAMP). In this model, the technical aspects of the AM program can be evaluated by people who know the ecology, hydrology, biology, etc. while the political body would determine whether and how to act on the information within the regulatory contexts of the BiOps, 2081(b) permit, and other relevant authorizations (e.g., USACE permits, State Board authorizations).

Perhaps because of its explicit connection to Section 7 compliance, the AM Framework features an agency-based oversight committee ("Five Agencies") with the IICG underneath it. An agency based oversight committee, as opposed to a politically based one like CSAMP, is fine as long as there are clear guidelines on the criteria for adjustment and clear boundaries within which it can take place. The oversight committee also needs to have authority to engage in (sometimes controversial) experimentation to provide the leadership and legitimacy to actually try new things. The oversight committee also needs a political mechanism to fall back to if monitoring results are outside of the bounds set, e.g. a trigger for reinitiation of Section 7 consultation. Without these features, the oversight committee is likely to make either meaningless adjustment, or be vulnerable to litigation every time it does.

The current arrangement does not appear to be embedded within adaptive governance, which does not bode well for truly responding to the feedback from monitoring. However, a good alternative is to be very clear up front on: (1) criteria for adjustment (e.g. triggers, performance measures, actionable metrics that dictate when management changes will be implemented and/or when consultation will be reinitiated); and, (2) bounds within which adjustment can take place. The oversight committee can then resort to a legal or political decision-making process (likely leading to reinitiation of consultation) if results of monitoring fall outside the range expected.

The organizational structure outlined in the AM Framework describes a model where managers representing the "Five Agencies" are ultimately responsible for decision-making, but much of the work of implementing the AM program falls to the IICG, which is comprised of a mix of agency scientists and water users. It is important to note that while the agency people may be a mix of science and management, the local water authorities are likely to be political – resulting in difficulty in determining their own criteria for making decisions, especially if they are connected to funding sources for the research and monitoring.

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An important governance role for the IICG and the Five Agencies has to do with decisions about what science and monitoring is funded and carried out. Given the large number of uncertainties associated with this project (highlighted in Section 4 and Appendices 2-5), it will be important for the AM Framework to have a clearly articulated strategy for prioritizing what science gets done (i.e. research, monitoring) and what habitat restoration is undertaken, in what order.

As Runge (2011) notes "*while uncertainty abounds in the management of threatened and endangered species, not all uncertainty is relevant to decision making. The uncertainty that matters is the uncertainty that would lead to different management policies, and it is useful to make sure that uncertainty matters before embarking on its reduction*. " We suggest the Five Agencies, in collaboration with CSAMP/CAMT, undertake efforts to distinguish between different kinds of uncertainty, e.g. uncertainty that is relevant to fish survival and recovery and can practically be acted upon vs. uncertainty that's not as critical to reduce at a given stage in the PA and/or that cannot really be acted upon, including those that are irreversible. An important subset of scientific endeavors that would reduce the first kind of uncertainty are ones that includes corresponding actions that are doable and promising for fish survival and recovery but not politically palatable. Those, in a nutshell, are the decisions that will be the hardest to make and the Framework should be explicit about how the IICG will handle those kinds of decisions.

We recognize the challenges associated with prioritizing what uncertainties to reduce and note that in the case of Delta Smelt and Longfin Smelt, for example, we may not have the information that would be required to weigh the relative value of various uncertainties. However, there might be merit in prioritizing estimating vital rates and generating space-stage specific life history models for the smelts, as is being developed for salmon, over trying to reduce uncertainty about how climate change will affect the fish, e.g., inundation rates in inner Delta.

The Panel did not find explicit mention about how this kind of prioritization for the key monitoring and research would take place but did note that in Fig 5-1, part of the "Research and Monitoring" cycle includes "Science teams ID science needs". The nearby box lists "Delta Science Plan Independent Science Review including LOBO and CSAMP Plans" but it is not clear exactly how decision-making will take place with coordination between IICG and these other entities. The Panel requests further clarification about who will be involved in making recommendations regarding funding and timing of various science endeavors.

Given that a No Jeopardy Opinion might rely on assumptions about the effectiveness of certain mitigation measures, it will be critical to monitor that effectiveness. For example, the PA does not seem to attempt to mitigate for NDD operational impacts on salmon except for the non-physical barrier at Georgianna Slough, 1.26 acres of habitat restoration, and perhaps reduced entrainment at the south delta. A recent study of non-physical barriers at Georgianna Slough shows some promise for reducing numbers of salmon passing into the interior delta, which should enhance survival to some degree, but it will be important for the Agencies to monitor barrier effectiveness. If the non-physical barrier works, then perhaps it could be applied in other locations. If monitoring determines that it is not working, there should be a contingency plan.

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Also, the effectiveness of habitat mitigation efforts designed to compensate for relatively short-term loss of salmon and smelt habitat at the NDD, and ultimately by long-term NDD operations, should be tested and monitored. As presented to the Panel, it simply calculates acres of damaged habitat and mitigates 3:1 (Table 5.4-1). Is this ratio sufficient to protect the ESA-listed species after existing habitat is damaged? Also, as discussed below, we suspect that the reported impact of 0.42 acres caused by PA operations greatly underestimates the amount of habitat that will be affected by removing up to 40% of Sacramento River water in some months and water years. Given uncertainty in PA effects on salmon, a precautionary approach may be needed when setting mitigation targets, i.e., additional mitigation may be needed. There is a table that shows these calculations by species which does not consider salmon size. It is mentioned here and there that smaller salmon use habitat differently but the analyses do not reflect this. The key problem is that these smaller juveniles may have a different, perhaps more adverse response to water diversion in the north delta compared with big yearling smolts. They do not discuss this potential bias, though mention the issue of large tagged fish. This issue is discussed elsewhere in this report.

Question 1A: Does the Framework adequately reflect comments and issues raised in Phase 1 of this review?

The Panel raised several concerns in the Phase 1 review about the approach to adaptive management, including the need for: more clarity on structured decision making; plans for monitoring; articulation of key uncertainties; development of a new decision making entity; identification of triggers ("performance measures" and "actionable metrics") for initiating changes; an explanation of the relationship between AM and real time operations; and more details regarding funding and external independent review, for example. We also asked for details about how research priorities would be set and suggested they be driven by gaps in conceptual models, e.g. Longfin Smelt vs. Delta outflow relationship.

The AM Framework represents a significant improvement in articulation of the vision, including the 4 phase AM model, a section on structured decision-making, and a description of a new decision making entity, the IICG. There are some details regarding plans for AM, however, that still need to be filled in.

First, we would like to see more clarification of the relationship between adaptive management and real time operations. One of our recommendations in Phase 1 was that the real-time operational decision making process be linked more explicitly to a formal AM program. In the cover letter accompanying the AM Framework as part of Phase 2a, the Agencies commented that "No such linkage is currently proposed, and this topic is expected to be further reviewed prior to issuance of the BiOps and Incidental Take Permit."

This statement seems to contradict background information we were provided with as part of the Panel's charge for Phase 2a, which states that *"moving forward, adaptive management will be utilized to integrate real-time operations, ongoing scientific research, monitoring, and long term operations of CWF within the SWP and CVP."*

The assertion that AM will be utilized to integrate real time operations with research, monitoring and long term operations seems to contradict the Agencies' comments and the contents of the AM

Framework. Therefore, we are still ~~somewhat~~ unsure what actions are associated with future real-time operational monitoring and what belongs in the AM Framework under the new CWF facilities. We would like to see more details about what safeguards and interventions belong in the real-time operational monitoring and what belongs in the AM Framework. We suggest that there should be a connection between the two, in the sense that real time actions help to achieve key fish performance metrics, e.g. through Delta survival of salmonids. Survival is a good metric, if it can be accurately measured, because it reflects all factors within the survival period (including climate).

Related to the issue of linking feedback from AM to real time operations is the issue of triggers. The Framework claims to include a list of triggers in the Framework Appendix 1 (ICF 2016), but much of what is listed in that table are not triggers to adaptively respond to factors affecting the covered species, rather they are mitigation measures. Mitigation should be monitored, of course (monitor mitigation effectiveness and fish performance) but each issue should have quantitative, measurable benchmarks (many do not). For example, the Framework should identify actions that might be taken if salmon performance targets are not achieved. Some salmon performance metrics are quantitative; are they measurable?

We asked for more information and assurances regarding the funding mechanism for both monitoring and research; but that has been deferred to later deliberations. The Panel would also like to see more details regarding how research priorities will be established, whether they will be driven by gaps in conceptual models (e.g. Longfin Smelt vs. Delta outflow relationship); and plans for independent review. As stated above, the Panel would also like to know more about the specific delegation of responsibilities among the entities that will oversee the AM program (i.e. IICG and Five Agencies, CSAMP/CAMT, etc).

Question 1B: Is the Framework sufficient to address the uncertainties associated with the current analyses and provide a timely mechanism for addressing future changes in operations based on new understanding of listed species distribution and abundance?

The Framework is a good start, assuming the scientific questions will be appropriately prioritized and actionable metrics will be developed to avoid jeopardy and adverse modification of critical habitat beyond that analyzed in the BiOps.

In regard to the handling of uncertainties, the Framework includes a good list of uncertainties and potential research topics, but it is unclear which uncertainties will be targeted for reduction through experimentation and learning. Critical uncertainties are well elucidated in Framework Appendices 1-6, but sometimes confused with “critical data and information gaps” that might not improve understanding of water operations effects on species of concern. We suggest a stronger link to conceptual models. It is difficult to extract where critical short-term actions (experiments) will be essential versus when “gaining knowledge to improved future management decisions” (adaptive learning) will be acceptable. It is somewhat unclear how the “best <u>unavailable</u> science” will be identified and implemented to support and advance adaptive management. In regard to uncertainties about salmon, the salmonid survival metrics are a good start, although survival is complicated by the variety of life history types passing through the Delta. Were the survival performance metrics identified in the Plan changed in the Section 4.3.7.2.3.1 (limited to 0.25 miles above and below the intakes)? Additional quantitative metrics could be developed that reflect viable salmon population (VSP) criteria, e.g., adult abundance of natural salmonids, R/S, spawning distribution, and pHOS in addition to Delta survival metrics. VSP is mentioned in the Plan (p. 28) but no metrics are discussed. See discussion above under *AM Governance and Decision Making* for more thoughts on how the Framework should handle uncertainty and some of the gaps in the current approach. Also, the Framework should be explicit about how the Agencies will handle uncertainties that cannot be reduced (i.e. how the precautionary principle will be implemented to ensure species viability and potential for recovery. It is encouraging to see the Framework incorporating climate change projections in its effort to reduce uncertainty.

In regard to whether the Framework provides "a timely mechanism for addressing future changes in operations on new understanding of listed species distribution and abundance" we suggest that the "mechanism" needs more detailed description. Will there be a mechanism for responding to unanticipated events on a timescale of less than 1-2 years? Because the framework is tied to Section 7, we suggest it may be more important than in other AM programs to have safeguards and sideboards. The Four Phase Plan gives a general idea of how the IICG will respond to new information, but the details regarding difficult decision making involving changing operations as warranted are not clear. How and when are the "adaptive limits of operations" established?

The framework seems like a cumbersome process with a 3-5 year turnover rate in evaluations (because of research funding cycles) with implementation possibility taking up to 7-10 years. The Panel suggests that there should be shorter feedback loops and more responsiveness and flexibility built into the AM approach. The Panel will need to review plans for real time operations in the BiOps before coming to any final conclusions, since the AM Framework only allows for annual adjustments. The issue of whether the AM program should be connected to real time operations also depends on the policies regarding experimentation. If there are plans for pulse type experiments, then AM will have to be linked to real time operations. The operations are key to design and carry out experiments, but a longer term approach is needed for evaluation and feedback.

Question 1C: How well does the Framework build off and incorporate existing adaptive management or related efforts? Does the Framework adequately address areas or gaps not currently covered by existing efforts?

The Adaptive Management Framework accurately encapsulates the basic tenants of the adaptive management concept that emerged in the late 1970's and has since been evolving as a major decision-making tool in resource management. In the context of California water and at-risk species management, the Framework appropriately emphasizes the need for a management regime that is "transparent, collaborative, and responsive to changes in scientific understanding," and specifically for improving management of the Delta's resources under federal and state water operations, including California WaterFix. The Framework translates the fundamental components and their interactions into a structured, four-phase decision-making process. This process recognizes the importance of using conceptual models to relate physical and biological processes that influence the condition of targeted resources and to identify the key uncertainties that constrain our current understanding of management actions effects on focal species and other ecosystem services. It also acknowledges the important distinction between "active" and "passive" adaptive management, although as noted later in this review the explicit experimentation involved in active adaptive management is seldom described in the Framework.

In identifying the major scientific and technical uncertainties, the Framework takes advantage of several other regional reports (MAST/SAIL) to develop an inventory of the most urgent research needs. While the Framework *acknowledges* the many gaps and uncertainties, it does not always address them in the sense of providing a path forward to resolve them. Rather, it defers to "ensure CESA authorization compliance as new scientific and operational information becomes available". The challenge will be for this list to be prioritized even further. Simply advertising the current complete list will populate the patchwork of science required to assess the effects of the PA but is not be seen as progressing the science effort as a whole without distinguishing and setting priority on the most critical science needs. It is also unclear what instruments will form the foundation research that everything else will be built on. Ultimately, the Framework would benefit from a more proactive 'strategic gaps' assessment of the critical information needs and experiments that would need to be conducted in the very short term.

The new Interagency Implementation and Coordination Group (IICG) would definitely be an improvement over existing efforts (CSAMP/CAMT), providing better articulation of uncertainties, a new decision-making entity and the mechanism to identify specific teams of people that would be appropriate for each research effort. It remains to be seen, however, whether the IICG will provide a strategic plan to monitor, experiment and learn, through both active and passive adaptive management.

Question 1D: How thoroughly do the steps and decision making processes outlined in the Framework support its intent and objectives?

The four phases of adaptive management are well described and are in alignment with the core principles in the AM literature. The decision making process appears to support the intent and objectives stated on pg. 6 of the document but the Panel has concerns about implementation of this decision making process. Assuming the "intent and objectives" of the Framework are to comply with Section 7 (i.e. protect the fish), then the adaptive management plan needs to be embedded in an adaptive governance structure that will ensure that they truly respond to feedback from monitoring. See general comments above regarding Governance and Decision Making.

The PA said the AM Framework would follow a similar model to the two tiered organizational structure of CSAMP/CAMT, but the IICG appears to be a different approach. How will authority be distributed between IICG and CSAMP/CAMT? Given that the mission of CSAMP was to develop a robust science and AM program to inform BiOps. Why not use CSAMP and CAMT to implement this AM Framework? The PA said CSAMP would be responsible for coordinating monitoring and research to assess efficacy of water operations criteria including: (1) Operational criteria proposed to take effect at the time of commencement of north Delta operations, and (2) alternative criteria that may provide equivalent or superior biological benefits while maximizing water supplies. Did this plan change, and if so why?

The AM Framework describes the IICG and lists the composition of the team (ICF 2016, 11). The vision for the IICG seems heavily weighted to water authorities and BOR and DWR. The IICG will have a "senior manager/scientist" from each of the Five Agencies. "Additional agency staff or consultants" may be added as needed, but this is not decided yet. As stated earlier, the Panel is concerned that the water users may have undue influence on scientific decision making. The Panel understands and supports the dominant paradigm in AM which calls for inclusion of stakeholder input in program implementation, but the Panel is concerned about stakeholders' (and especially water users') influence on the research prioritization.

The list of IICG duties are appropriate agency level management activities except for the last two. As the Agencies refine the list of duties for the IICG (p. 11), we suggest that #7 and #8, ("Establish mechanisms for developing and implementing adaptive management changes (e.g., identifying performance measures/triggers to assess progress/outcomes, providing venues for synthesis and evaluation of available information, peer review, and developing recommendations in the face of new/refined understanding)"), in particular, might not be appropriate for stakeholder input. As stated earlier, there does not appear to be a political body set up to make decisions if the monitoring information shows response outside the boundaries set for decision making. Again, the alternative is to set clear criteria and boundaries and have a process for political decision making if results fall outside of that. The Five Agencies should be the entity that will decide when and how management should change after reviewing results of research and monitoring (Phase 4). Biologists should not be involved in decision-making and should just serve in advisory roles since it otherwise could be a conflict of interest.

The Panel suggests that decision making processes regarding what research and monitoring gets funded and carried out in Phases 1 and 2 should be primarily based on input from personnel with scientific background. The Five Agencies should have a team of scientists and engineers advising them. If water users are included in an advisory function and will be involved in decision making regarding research, then other stakeholders, including representatives from environmental groups, should be included as well (as in the CSAMP/CAMT process).

In regard to Phases 3 and 4, Integration and Adaptation, the Panel would like more information about governance and decision making in these phases. How will a culture of risk and experimentation and learning be supported?

Question 1E: Do the commitments to new research, monitoring, and modeling appropriately support the management component of the Framework?

In the Phase 1 review, the Panel asked for explicit plans for ongoing monitoring of the status of the species and the direct and indirect effects of (1) the design of fish facilities (the footprint of the PA installation), (2) the operations (whether the PA is jeopardizing species or adversely modifying habitat), and (3) restoration and mitigation activities.

As acknowledged in the cover letter accompanying the AM Framework responding to the Panel's Phase 1 comments, the Agencies have deferred details to the forthcoming BiOps and ITS, therefore the monitoring plans still need to be developed in sufficient detail. Section 6.3 identifies positive steps to provide information needed to better manage and rebuild salmonid populations. These proposed efforts should be discussed and evaluated further in a detailed monitoring and research plan. Each effort should be linked to specific questions and adaptive management triggers.

The Panel notes the inclusion of a section on Funding, which states that "[c]urrent and anticipated funding requirements and timelines will be determined through Five Agency coordination and with the IICG." Will funding sources be contingent on stakeholder or water user access to decision-making? If so that could create a conflict of interest.

The Framework states that "much of our most valuable monitoring and analytical tool development suffers from a lack of long-term funding security and fragmented implementation, which together lead to inefficiencies in applied science to better inform management decisions." Since these details and assurances are still missing, it makes evaluation of adequacy and effectiveness difficult.

The Panel has some concerns about capacity for carrying out the envisioned research and calls attention to the problem of attrition in Delta Science experts due to retirement and a failure to replace those leaders, especially in state and federal agencies. This is resulting in a knowledge base draining and the Agencies should proactively plan for recruiting the necessary lead researchers and research technicians. How will the Agencies address the need for additional resources, people, and capacity for research?

Question 1F: Will the approaches to scientific research and monitoring allow robust and adequate documentation of effectiveness in reducing uncertainty associated with CWF and existing measures to minimize and mitigate impacts to species?

An annual review and report on the status of key indicators and an evaluation of results from actions and experiments is crucial. The Panel is optimistic about the ability to document and track the results of scientific research and monitoring if the research is guided continuously by the newly formed IICG group rather than in a patchwork fashion as has been done in the past. The Agencies and IICG will need to articulate how they will determine effectiveness in reducing uncertainty and what criteria they will use to determine effectiveness. The larger issue, however, is whether and how the envisioned science program will be carried out.

There are two inherent aspects to the WaterFix uncertainties: (1) how priorities will be assigned to the key scientific uncertainties that constrain realistic estimation of PA impacts on listed species; and, (2) uncertainty in the approach and commitment of the responsible agencies to new and expanded monitoring, research, modeling and analysis that will be required to address (1). It is certain that the existing capacities under current monitoring and research (e.g., Interagency Ecological Program IEP) are already strained and that both funding and science resources will need to be amplified to meet this additional need. For instance, the considerable uncertainties around the population dynamics of Delta Smelt, that already constrains the interpretability and application of the Delta outflow-Longfin Smelt abundance relationship, will require additional science investigations of PA impacts across life history stages, regions of the Delta and Bay and time periods that are not presently addressed.

Question 1G: Will the approaches to scientific research, monitoring, and associated decision making allow for tracking the effects of CWF on populations of the four listed species over time and the effectiveness of management actions?

This question is similar to Question 1F in that it is concerned with the ability to track results of research, monitoring and decision making. As stated earlier, the Panel would like to see a comprehensive research and monitoring plan before answering this question.

This is going to be a very slow process. There needs to be a more dynamic component as well.

Do the beginning operating criteria for NDD make sense? Are the I:E ratio and OMR criteria currently used to operate the system the appropriate starting point?

Monitoring needs to be designed to have the capability to assess the outcomes of adaptive management and mitigation actions and their implications for the survival and recovery of ESA-listed species. The criteria for determining "effectiveness of management actions" needs to be explicitly described. While tracking the effects of CWF and associated management actions in an effective manner is certainly critical, the Panel's bigger concern around decision making has to do with transparency and accountability regarding how decisions will be made in response to what is tracked.

3.1.3 CDWF 2081(b): general permit questions

To what extent are the analyses used for the CDFW 2081(b) permit application scientifically sound and their conclusions scientifically supported?

The application recognizes where uncertainty limits the type of analyses that can be defendably employed. For those analyses that can be defendably employed, the methods are generally sound and are scientifically supported. The conclusions regarding take and jeopardy of Chinook salmon are not scientifically supported. Detailed answers to this question are discussed for each question below.

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Question 2A: Do analyses of CWF operations and impacts to species through 2060 resolve panel comments raised in Phase 1 of this review? Is climate change adequately incorporated into the cumulative analysis?

Delta Smelt:

Thermal effects depend on results published by Brown et al. (2016), but the application did not consider climate effects beyond 2039 due to uncertainty in future trends in greenhouse-gas emissions. Two, widely divergent emission scenarios were applied by Brown et al. (2016) to predictions that extended to the year 2100. The panel assumes that the application did not consider climate effects beyond 2039 due to mid-century divergence in the two emission scenarios that were evaluated by Brown et al. (2016).)., which extended to the year 2100. Impacts related to future climate-related changes in X2 are based on 2025. It is acknowledged that entrainment at the NDD may increase due to increasing sea level. Higher water temperatures are expected to cause habitat compression and reduced reproductive potential under both the PP and NAA to comparable extents. Higher air temperatures are expected to shift precipitation away from snow and towards rainfall, changing seasonal and spatial snowmelt patterns and thus inflow (Section 5.A.A.2, Appendix 5.A- Attachment 2). These positions are incorporated into the cumulative effects. Given that Delta Smelt are already in the vicinity of the NDD (evidence follows below), and that most Delta Smelt habitat is downstream of the NDD, sea-level rise would be expected to cause a larger proportion of the Delta Smelt population to be impacted by the NDD.

Beach-seine stations (n = 58) are maintained throughout the legal Delta as well as in upstream and downstream areas. Despite the broad geographic distribution of stations, two of the top five stations with the highest Delta Smelt catch were located near or upstream of the NDD. The top five beach-seine stations for Delta Smelt in recent years (highest sum of catch, Table 1) are:

1. SR012W – Sandy Beach, Seine Route North Delta, Region 2 – downstream of NDD
2. SJ001S – Antioch Dunes, Seine Region Central Delta, Region 3 – downstream of NDD
3. SR049E – Garcia Bend, Seine Route N. Delta & Sac, Region 2 – upstream of NDD at river mile 49
4. SR043W – Clarksburg, Seine Route North Delta, Region 2 – near upstream-most intake at river mile 43
5. SS011N – Steamboat Slough, Seine Route North Delta, Region 2 – downstream of NDD

Table 1. Comparison of recent (2012-2016) catches of Delta Smelt at different beach-seine stations, where *Count* is frequency of encounter (number of seine deployments with non-zero catch) and *Sum* is the total number of individuals collected. Stations are sorted by their sums, with the top five stations highlighted in yellow (data source: https://www.fws.gov/lodi/juvenile_fish_monitoring_program/jfmp_index.htm).

Station	*Count*	*Sum*

SR012W	31	140
SJ001S	5	88
SR049E	8	39
SR043W	3	20
SS011N	2	9
LI001E	4	8
LI003W	5	8
LI006E	5	7
SR014W	6	6
SR060E	3	5
LI010E	2	4
LI005W	2	3
LI006W	3	3
LI007E	3	3
MK004W	3	3
SR024E	1	3
SR062E	3	3
GS010E	1	2
LI007W	2	2
TM001N	1	2
LI001W	1	1
LI002E	1	1
LI008E	1	1
SJ026S	1	1
SR055E	1	1
Totals	98	363

Salmon

The CWF ITP briefly mentions the predicted effects of climate change on salmon habitat, but the analysis is incomplete. The report states in Climate Change sections 4.3.8.2 and 4.4.8.2: *"Some global climate models (GCMs) predict that summer water temperatures in the Sacramento River and its tributaries may increase by 3°C to 6°C by the end of this century, which would result in a greater frequency in exceedance of lethal water temperature thresholds." "Predicted reductions in reservoir cold water pool storage volume would diminish the capacity of managers to counter water temperature increases resulting in a greater frequency in exceedance of lethal water temperature thresholds."* Climate effects on stream flow were briefly noted, but changes in flow by season should be discussed in more detail so that effects on each salmon species and life stage can be evaluated. Climate-related impacts on salmon habitat were projected to be much greater after year 2030, but the modeling effort to evaluate PA effects on salmon only considered climate-related effects through 2030. The CWF ITP concludes: *"These impacts would occur regardless of the PP, for the effects are not evident when compared to the NAA."*

The CWF ITP should further justify its conclusion that climate change would not differentially impact salmon via the PP versus NAA. For example, findings from the Delta Passage model (e.g., section 4.3.4.1.2.2.1.6) indicate that the PP would lead to slightly lower survival of salmon through the Delta compared with the NAA, and the IOS life cycle model indicates a 25% reduction in median spawning escapement of winter Chinook under the PP compared with the NAA. The reduction in survival under the PP compared with the NAA is expected to be greater during dry versus wet years. The frequency of drier years is expected to be greater during future climate change, especially after 2030, which is the last year considered in the CWF ITP modeling effort. Therefore, the frequency of lower survival conditions under the PP compared with the NAA may be greater during projected climate scenarios, especially as year 2100 is approached.

Survival of salmon during life stages outside the Delta (e.g., spawner to smolt, and ocean rearing) is likely to be lower during future climate change in response to less favorable temperature, stream flow, and perhaps ocean conditions. Therefore, a slight negative impact of the PP on salmon survival is likely to have greater consequences for the viability of salmon under future climate scenarios than scenarios that were modeled through 2030 when climate change effects were relatively small. In other words, a reduction in survival while migrating through the Delta in response to the PP (e.g., p. 4-413) would have greater consequences for salmon viability towards the end of the century when additional factors are adversely affecting viability compared with the contemporary period. This observation differs from that view of no differential impact presented in the CWF ITP.

Future climate change, especially after 2030, will likely lead to a longer series of years with stressful conditions for salmon. The carry-over effect of continuous adverse conditions is best evaluated using a life cycle model that incorporates previous-year effects on parent spawning abundances. The CWF ITP used two life cycle models for winter-run Chinook salmon: IOS and OBAN, but OBAN did not consider future climate scenarios. IOS considered climate change factors through 2030 (ICF, personal communication), but it did not specifically address periods of long-term drought beyond what was observed in the modeled years (1926-2002 and adjustments for climate through 2030; ICF, personal communication). IOS considered factors affecting salmon during several life stages in the Sacramento River and used the Delta Passage Model for PA effects in the delta. A key prediction from IOS was that median adult spawning escapement of winter-run Chinook salmon was 25% less under the PP versus NAA across the 81-year period (Section 5.D.3.1.8.4). During dry and critical water years, median adult spawning escapement declined about 30-70% under the PP compared with the NAA (Fig. 5-D-150).

ICF consultants noted that the effects of climate change on the ESA species beyond 2030 need not be addressed in the final BA, but updated models will need to be considered in the future and adaptive management will be used to address future conditions. This comment by the consultants highlights the need for a robust adaptive management program. Based on input from NOAA personnel at the public meeting (December 8 and 9), we anticipate that the NOAA BiOP will further address the carry over effect of long-term drought on salmon viability under the PP versus NAA. The Panel also notes that climate change and associated rise in sea level might offer some mitigating effects if tidal and wetland restoration activities actively plan for and respond to sea level rise.

Question 2B: The 2081(b) application currently utilized long-term averages to analyze near and far field effects of CWF operations on habitat conditions. Does this approach adequately describe year-to-year effects of CWF on covered fish species' population dynamics? Are there alternative analytical approaches available that are more appropriate?

Delta Smelt

Population dynamics were not modeled due to widely recognized uncertainties in model parameterization. Year-to-year variation in individual effects (entrainment, X2, abiotic habitat index) were considered by water-year type. However, water-year type cannot represent monthly conditions because it is based on differently weighted flows during particular seasons plus the weighted index for the previous year. Given that the Delta Smelt is an annual species (i.e., each year class must survive continuously and then successfully reproduce), additional analyses should have been based on months that were independent of water-year type. It appears that averaging months within water-year classes diminished the numerical difference between the PA and NAA.

Because wet months can occur during dry years and vice versa, classification by water-year type does not effectively segregate months along the wet-dry axis, and therefore differences among water-year average monthly values may falsely appear to be diminished. In addition, the water year index

Sacramento River Index = 0.4 * Current Apr ‑ Jul Runoff + 0.3 * Current Oct -- Mar Runoff + 0.3 * Previous Year's Index

is more heavily weighted towards April-July runoff, does not represent flows during August or September, and is biased by the previous year's index. The Delta Smelt, as an annual species, must successfully reproduce even during what are defined as "critical" water years by this index. That is, survival to reproduction requires survival during all months and all years by every year-class of fish. However, even with the diminishment of apparent differences caused by averaging, there appears to be a meaningful difference in X2 between the PA and NAA, particularly during August and September, when X2 has a large likelihood of retreating into the river channels upstream of Chipps Island (Figures 5.A.6-29-18 and 5.A.6-29-19, Appendix 5.A). Even with this conservative (averaged) approach, there appears to be a difference of several km within important river reaches that separate the river channels from critical shallow-water habitats downstream that are used as rearing habitat by early juveniles during August and September. The actual effect observed under the PA is likely to be much larger and more frequent than indicated in these plots. Separation of X2 from critical shallow-water habitat in the vicinity of Suisun Marsh, Honker Bay, and Montezuma Slough is cause for concern.

Salmon

The CWF ITP should consider effects of the PP versus NAA in response to prolonged drought conditions so that the propagative effect of low salmon productivity during each life stage and each generation can be examined. A life cycle model provides the framework for this type of analysis. Two life cycle models were described in the CWF ITP, but these models only considered climate change effects through 2030 based on adjustments to base period observations (1926-2002). We understand that NOAA Fisheries will present a comprehensive life cycle model in the BiOP that will be used for addressing long-term drought conditions under the PA versus the NAA.

Question 2C—Part A: Is the approach used to characterize take and associated impacts to covered fish species populations scientifically valid given current understanding and the recognized limitations of available tools?

Salmon

The CWF ITP uses a variety of approaches to estimate effects on salmon of the PA relative to the NAA. These approaches typically rely upon available data and models that have been developed in the watershed rather than attempting to develop new models and approaches specific to the WaterFix Project. The report attempts to highlight assumptions, limitations, and uncertainty of the analyses. More detailed documentation of assumptions and limitations of the modeling effort is typically found in Appendix.

The salmon models did not always incorporate the most recent information, which is continually evolving as new studies are published. For example, the IOS life cycle model used egg survival relationships based on a 1999 laboratory study that reportedly over-estimated egg survival in the Sacramento River in relation to water temperature (Martin et al. 2016). Other salmon egg mortality estimates in the report were likely based on the same or similar laboratory data and should be updated with these new findings. The Martin et al. (2016) study was published by NOAA scientists, so we expect the BiOP to incorporate this new information.

The Delta Passage Model is a key tool to estimate survival of salmon through the delta, and it should be updated and re-run with more recent survival data, if possible. Many survival studies have been conducted since the initial development of the model. The Delta Passage Model was developed from the tagging of large hatchery yearling fall Chinook salmon smolts. A key uncertainty when using the Delta Passage Model is that the findings may not be representative of smaller wild winter and spring run Chinook salmon. Salmon fry and parr rear in the estuary for longer periods and use different habitats compared with larger smolts, such that application of the smolt survival data as surrogates for smaller Chinook salmon may lead to biased survival estimates. Since smaller juvenile Chinook salmon rely on estuarine habitats for longer periods than larger yearling Chinook, we suspect that removal of up to 40% of the Sacramento inflow (e.g., November of below normal years) may have a greater effect on these smaller life stages than indicated by the tagging of large hatchery fall Chinook salmon. Michel et al. (2015) noted that smaller Chinook salmon passing through the delta likely have lower survival compared with the large hatchery fall Chinook salmon because they are smaller and more vulnerable to predators. Examination of mean size of juvenile Chinook sampled in the delta during 2012-2016 (beach seines vs. Chipps Island trawls;

https://www.fws.gov/lodi/juvenile_fish_monitoring_program/jfmp_index.htm) shows that sizes of winter- (73 mm in beach seines; 114 mm in trawls), spring- (58 mm in beach seines; 89 mm in trawls), late fall-run (78 mm in beach seines; 134 mm in trawls), and fall (44 mm in beach seines; 82 mm in trawls) Chinook salmon races are much smaller than the sizes of hatchery fall Chinook salmon used in the Delta Passage Model (>140 mm). Salmon sampled by trawl were consistently larger than those in beach seines, as expected. Salmon sampled by trawl at Sacramento were 10-30 mm smaller than those at Chipps Island, suggesting considerable growth and residence in the Delta by Chinook salmon. The smallest size of winter-run and spring-run Chinook salmon sampled by beach seine in the Delta during 2012-2016 was 35 mm and 31 mm, respectively. These small salmon may be more vulnerable to water removal effects and associated changes in habitat than larger hatchery salmon used in the models.

Ultimately, a life cycle model approach is probably the best approach for evaluating cumulative effects of the project on salmon viability (see Rose et al. 2011). A life cycle model enables projected effects to be propagated from life stage to life stage and from generation to generation while also enabling the evaluation of long-term environmental change, e.g., droughts and changes in habitat. The IOS model is the most comprehensive life cycle model described in the report. It incorporates functional relationships for several life history stages that would be influenced by the PA, including survival through the delta based on the Delta Passage Model. The OBAN life cycle model uses a statistical approach, but it uses a range of simple survival assumptions to characterize survival through the delta rather than reliance on empirical data, such as the Delta Passage Model. The IOS model should be updated with new information on: 1) the relationship between egg survival and temperature in the Sacramento River (Martin et al. 2016); and, 2) survival of Chinook salmon passing though the delta. The Panel was informed that NOAA fisheries is developing a more comprehensive life cycle model that will be used in the BiOP.

Question 2C—Part B: Are there improvements to the current methods that could be implemented, or are there available alternative analytical approaches that are more appropriate for analyzing the extent of take and associated impacts to the species?

Delta Smelt

For Delta Smelt, additional investigative approaches are outlined in Table 4.0-1 of the permit, but these are limited to specific, estimated impacts (entrainment, X2, flow relationships with fish, etc.) and did not include impacts that were avoided altogether due to uncertainty (e.g., food-web and population dynamics). More comprehensive life-cycle models are needed to integrate survival across life stages and water years while considering key factors. See recommendation by the Salmonid Life-Cycle Model Independent Panel (Rose et al. 2011) and the following discussion.

Salmon

As noted in our answer to Question 2C-Part A, the CWF ITP analyses rely on data stemming primarily from relatively large Chinook salmon (typically > 140 mm) even though sampling in the Delta show that winter-run and spring=run Chinook salmon are typically much smaller than this. According to beach seine data, juvenile winter-run and spring-run Chinook salmon as small as 35 mm and 31 mm, respectively, have been sampled. These data and the current reliance on much larger salmon for impact analyses highlights the need for a significant research effort on salmon fry and parr distribution, abundance, behavior and survival in the Delta (including predation impacts). This information is needed to 1) inform life cycle models, 2) more accurately characterize potential effects of the PP versus NAA, and 3) develop habitat restoration actions for juvenile salmon in the Delta.

Question 2D: Do the conclusions of the effects analyses for covered species adequately acknowledge and incorporate uncertainty as recommended in Phase 1 of this review?

Delta Smelt

Most uncertainty regarding Delta Smelt was adequately addressed. One Phase 1 recommendation that was not fully addressed is concern that the PA will frequently move X2 several km upstream into channel-type habitats (upstream of Chipps Island) and away from critical shallow-water habitat in the Suisun Marsh, Honker Bay, and Montezuma Slough area used as rearing habitat. As mentioned in the answer to Question 2B, the water-year-averaged X2 statistics presented in the CWF BA do not assuage this concern. Other highly relevant uncertainties that were not considered (or identified during Phase 1) include ongoing adjustments that will affect actual future inflows and ongoing adjustments to operations at the SDD (re-initiation of 2008 FWS BiOp, 2009 NMFS BiOp RPA Action Suite 1.2).

Regarding upstream displacement of X2 under the PA, please refer to the Panel's expanded answer to Question 2B. Regarding other uncertainties, a variety of adjustments are underway that will change flow rates and the way diversions are operated. Given the high probability of these changes occurring in the near future, the criteria and simulated data used in the CWF BA simulations may soon be superseded by new criteria and simulated data, causing the CWF BA to become unrepresentative of actual PA effects and the NAA.

Statistical UncertaintyThe Panel is pleased to see a heightened emphasis on uncertainty in the 2081 permit application, relative to what we saw in the draft BA. This greater emphasis is apparent in Section 4.0 of the Take Analysis (Ch. 4), especially in Table 4.0-1,

The Panel also appreciates that Chapter 4 now reports quantitative uncertainties more realistically in several ways, relative to the BA, along the lines suggested in our review of the BA (Simenstad et al. 2016). However, the Panel is still concerned about how Chapter 4 draws its conclusions about the predicted outcomes of PP and NAA scenarios, in the face of the uncertainties of predictions from its statistical models.

In Chapter 4 and its appendices, the Panel found 9 applications of regression models that compare PP to NAA outcomes over the 82-year projection scenario. We will use one such model as a working example, the simple linear regression that predicts the April-May salvage of juvenile Longfin Smelt as a function of April-May OMR flow (Appendix 4.A.1.6). This regression model takes the form:

$Y = a + bX + e$,

where *Y*= log10(juvenile salvage), *X* = (OMR flow), *a* and *b* are estimated regression coefficients, and *e* is the model's residual error (section 4.A.1.7).

In the Results (4.A.1.8) section, this model's predicted exceedance plot (Fig. 4.A-32) and time series plot (Fig. 4.A-33) display true 95% prediction intervals for predicted salvage under the NAA and PP scenarios, rather than confidence intervals used in the draft BA, as recommended by Simenstad et al. (2016). The use of prediction intervals gives a much more realistic picture of model uncertainty, and the Panel appreciates the additional effort exerted to develop such intervals for this and the other statistical models. In addition, as recommended by Simenstad et al. (2016), Figures 4.A-32 and 4.A-3 do not display the predicted mean values for PP and NAA, a practice that emphasizes the uncertainty that the predicted means would be the true outcomes of the scenarios.

However, Chapter 4 does not draw its conclusions about PP and NAA outcomes from its time series plots and exceedance plots that display prediction uncertainty. Rather, conclusions in the Chapter 4 text are consistently based on face-value interpretations of predicted mean values, as reported in tables (e.g., Table 4.A-11) and boxplots (e.g., Figure 4.A-31), neither of which include model uncertainty. For example, the first sentences of the Results section (4.A.1.8) summarize the regression results by stating "Predicted salvage from the salvage-Old and Middle River flow regressions generally was less under the PP in wetter years and greater under the PP in drier years (Table 4.A-11 and Figure 4.A-31). The mean salvage in wet and above normal years was within 14-15% less under PP, similar (3% greater under PP) in dry years, and nearly 30% greater under PP in below normal years (Table 4.A-11)." Similar wording is used throughout Chapter 4 when interpreting results from the other 8 statistical models. (The panel does appreciate that the boxplots in Ch. 4 and its appendices now note their exclusion of model uncertainty, as recommended by Simenstad et al. 2016. However, we note that Chapter 4 did not attempt to propagate model uncertainty into the boxplot results, although Simenstad et al. 2016 suggested 3 ways that this could be done).

The Panel is especially concerned about using the face values of predicted means to summarize the *differences* between PP and NAA outcomes, without considering their uncertainties, as is illustrated in the preceding paragraph. Making a realistic interpretation of the predicted differences between NAA and PP is critical, because the overall message of the statistical models in Chapter 4 is that such differences are either quite small, or that they indicate less impact to ESA fishes under PP than under NAA.

Thus, the Panel believes that it is important for the Chapter 4 authors, and their readers, to fully understand a hidden, but critical, assumption that underlies the use of predicted means to estimate differences between NAA and PP. To understand this assumption, consider the residual error term, *e*, in the above regression equation. For our example regression, the error term is not negligible, because r^2=0.70. Thus, the residual error accounts for $100(1-r^2)\%$ = 30% of the variance in log10(salvage)). The residual error can be viewed as the sum of contributions from 2 sources: $e = F + M$. In this expression, *M* is "measurement error", that is, the random error that occurs because Longfin Smelt salvage cannot be measured with perfect accuracy and precision. In the case of smelt salvage, the measurement error may be relatively small.

This is a DRAFT of the Phase 2a report (1/20/2017). The final Phase 2a report will be submitted on 01/27/2017. Comments/recommendations in the sections related to Adaptive Management are preliminary. All responses in the 2/17/2017 final report will supersede comments/recommendations made in this DRAFT report.

We focus instead on the other error component**,** *F,* which represents “other factors”. This is the model error that occurs because, among all the factors that probably impact Longfin Smelt salvage, river flow (X = OMR flow) is the only factor that is included in the regression model. Conceptually, several such other factors are known, such as smelt population size and population dynamics, predation effects, screening efficiencies at the South Delta salvage facility, and migration dynamics. These other factors are not included in the regression model because the current state of science cannot yet quantify their effects on smelt salvage, either empirically or theoretically. As a result, the individual and joint effects of all these other factors (including their interactive effects with flow) are implicitly bundled together and modeled as a single component, F, of the residual error. This situation is also true for the other 8 model applications, with the possible exception of the Newman (2003) model. That is, the sole driving variable is some hydrodynamic measure (generally OMR flow or X2) that is assumed to differ under PP and NAA, and all other types of factors are excluded from the models.

For any year in the 82-year projection sequence, the regression model is used to predict Y_{NAA} = log10(salvage) for the NAA scenario, assuming the OMR flow level, X_{NAA} of that scenario:

$$Y_{NAA} = a + bX_{NAA} + F_{NAA} + M_{NAA} \qquad (1)$$

In Equation 1, F_{NAA} and M_{NAA} are the “other factor” and “measurement” components of the residual error, e, that are assumed to occur under the NAA scenario for the modeled year.

The regression model is then applied once more, to make corresponding predictions for the PP scenario:

$$Y_{PP} = a + bX_{PP} + F_{PP} + M_{PP} \qquad (2)$$

The difference between PP and NAA outcomes can then be estimated by subtracting Equation 1 from Equation 2:

$$Y_{PP} - Y_{NAA} = b(X_{PP} - X_{NAA}) + (F_{PP} - F_{NAA}) + (M_{PP} - M_{NAA}) \qquad (3)$$

In Equation 3, the term $b(X_{PP} - X_{NAA})$ is the difference between the predicted mean values under the PP and NAA scenarios. Since Chapter 4 assumes that this difference accurately estimates the difference in log10 (salvage), which is ($Y_{PP} - Y_{NAA}$), then it also assumes that the second and third terms on the right-hand side must sum to zero, on average. There is no reason to expect that measurement error would differ, on average, between the PP and NAA scenarios, so one can assume that $(M_{PP} - M_{NAA}) = 0$. However, this implies that one must also assume that, on average, $(F_{PP} - F_{NAA}) = 0$.

This final assumption is of critical importance. It states that: *all salvage-associated factors, other than OMR flow, are assumed to have average, total effects on salvage that are identical under the PP and NAA scenarios (that is, $F_{PP} = F_{NAA}$)*. Thus, even though Chapter 4 does not explicitly model any of these other factors, such as smelt population size and predation pressure, it is implicitly assuming that the Proposed Project would not alter their quantitative effects on smelt salvage, relative to NAA. This strong “excluded-factor” assumption, which has questionable realism, is applicable whenever the face-value differences between predicted mean values, without prediction intervals, are used to compare NAA and PP outcomes.

In contrast, the prediction intervals around the predicted means express a 95%-confidence range of possible nonzero values for the residual error, $(F_{PP} - F_{NAA}) + (M_{PP} - M_{NAA})$. If these intervals were incorporated into the comparisons between NAA and PP predictions, then such comparisons are more robust, in that they represent the more-realistic likelihood that factors excluded from the regression model have differing effects on salvage, under the PP versus NAA scenarios.

The preceding arguments apply to any regression model in which the residual error is defined as the difference between predicted and observed values, including the multiple linear regression, Poisson and logistic regression, local regression (LOWESS), and negative binomial formulations used in Chapter 4.

Although we believe the excluded-factor assumption to be important, the Panel does not suggest a practical alternative to citing the predicted means from PP and NAA predictions, when summarizing regression results in the Chapter 4 text. Attempts to incorporate prediction-interval information into the textual summaries are likely to be cumbersome and unclear, although we encourage the Chapter 4 authors to give it a try.

However, the Panel does recommend that text be added, probably to Section 4.0, about “model uncertainty” and how it will be addressed throughout Chapter 4. This text could specify the types of models for which uncertainty can be estimated, and acknowledge that model uncertainty is still present in models (e.g., CalSim?) where estimation is not possible. For regression models, the text could explain when and how prediction intervals would be reported and interpreted. Finally, the text could state how the predicted means would be reported (boxplots and means tables), and would explain the excluded-factor assumption that underlies interpretations of differences between the predicted means for PP and NAA.

For salmon, an additional uncertainty stems from the use of surrogates to estimate survival of winter and spring-run Chinook Salmon migrating through the delta. The Delta Passage Model, a key tool for evaluating the PA, was based on tagging of large yearling hatchery fall Chinook salmon. Smaller juveniles rear in the estuary for longer periods and they typically use shallower habitats compared with larger Chinook salmon smolts (Miller et al. 2010, Sturrock et al. 2015, Weitkamp et al. 2014). The CWF ITP briefly mentions this limitation of the existing Delta Passage Model, but this limitation is not considered when developing conclusions regarding Take and Jeopardy. Given the greater reliance of smaller Chinook Salmon on shallow estuarine habitats and the proposal to remove up to 40% of Sacramento River discharge at the NDD (November of below average water year), we suspect the reliance on large smolts as surrogates for smaller juveniles may underestimate potential adverse effects of water on winter and spring run Chinook salmon. The CWF ITP should discuss the potential direction of bias that the use of large smolts will have on the evaluation of take.

3.1.4 CDWF 2081(b): Longfin Smelt questions

Question 3A, 3B: (3A) Is the proposed approach to achieve the March through May spring outflow targets for Longfin Smelt likely to result in spring outflow equivalent to existing conditions? (3B) The relationship between outflow and Longfin Smelt abundance uses a six-month (January through June) averaging window (Kimmerer 2009). How well does the 2081 (b) application justify using a three month (March through May) averaging window to provide outflow targets and operational criteria during that period?

Evidence and existing analyses, albeit limited, would appear to argue for a six-month (January-June) averaging window. Methods of assessing declines in Longfin Smelt used to evaluate potential effects of the PP are extensively based on correlative analyses, with more recent evaluations derived from population dynamics models. Jassby et al. (1995) and Kimmerer et al. (2013) compared that January-June time window to averaging X2 over a more restrictive March-May. In their analysis of BDCP effects, Mount et al. (2013) considered the seasons of sensitivity of longfin smelt to changes in flow conditions to be February-March for juveniles and December-February for adults. Norbriga and Rosenfield (2016) used a February-May indexing period for age-2 Longfin Smelt to estimate age-0 larvae when their center of distribution is near X2. The ICF 2081 (b) analysis (Appendix 4.A) of adequacy of fit for the January-June X2 compared to the March-May averaging periods found that the January–June X2 averaging period was better supported in terms of explaining variability in the FWMT index (Table 4.A-1; Figure 4.A-1).

Yet, the Delta outflow-Longfin Smelt abundance are adequacy of fit relationships rather than mechanistic relationships to abundance or survival. Thomson et al (2010) and MacNally et al. (2010) related Longfin Smelt abundance to X2 flow relationships, but also identified water clarity and prey as additional explanatory factors. The more recent Maunder et al. (2015) state-space population dynamics model applied to Longfin Smelt in the Bay-Delta was cited in the ICF 2081 (b) analysis and highlights the uncertainties about mechanisms underlying the vital rates of Longfin Smelt populations. Evaluating covariates that affect the vital rate of survival between two life stages, Maunder et al. (2015) found that two (Sacramento and Napa rivers runoff) flow variables were the strongest single covariate but that there was "definite evidence" for density dependence, e.g., *Eurytemora affinis* abundance, as well as ammonia and temperature as additionally relevant covariates.

Given the inadequacies of the current monitoring regime and protocols (e.g., often designed for other species, restricted habitat and time coverage), can these correlative analyses resolve the uncertainties about how flow modification (e.g., location of withdrawal) will actually affect Longfin Smelt population dynamics? The ICF 2081 (b) analysis acknowledges that the historical flow-Longfin Smelt abundance relationship "….could change as a result of the PP (e.g., change in balance between north and south Delta flows for a given X2)." [4.A.1]. Uncertainties around the population dynamics of Longfin Smelt, that underlie the processes accounting for the outflow-Longfin Smelt abundance relationship have been identified as substantial, including evidence for: occurrence and variation in critical time periods (e.g., winter vs. spring); evidence for the importance of retention in the low salinity zone and its variation with outflow; smelt use of tidal wetlands and potential for benefit from food production exported from restoration sites; and the breadth of their distribution in the Delta, Bay and nearshore coastal ocean (5.3.2.3.2). As mentioned elsewhere, investigating these uncertainties will require additional empirical and modeling research of PP impacts across life history stages, regions of the Delta and Bay and time periods that are not presently addressed.

The available data and interpretations of emerging evidence acknowledge that the distribution of Longfin Smelt, particularly spawning adults and larvae, is much broader, and involves more shallow water habitat, than was previously appreciated (Grimaldo et al. in review). Similarly, the lack of definitive information on stage-specific habitats occupied by Longfin Smelt for spawning, hatching and rearing is inhibiting population dynamics and life cycle modeling needed for CWF assessment. The Adaptive Management Framework will need to expand/modify research and monitoring to resolve underlying mechanisms underlying the Delta outflow-Longfin Smelt abundance/survival relationships and utilization of shallow water habitat for spawning and rearing in the brackish zone. The agencies need to recognize that our knowledge of Longfin Smelt distribution and ecology in the Bay-Delta is based on monitoring programs designed for other species and in regions or habitats (e.g., shallow waters or tidal marshes) that were not originally incorporated into a study design that would target Longfin Smelt. Assessment of the potential effects of the CWP on Longfin Smelt population will depend on a much more mechanistic understanding of their somewhat impracticable response to spring outflow.

It should be noted here that export of Longfin Smelt Still juveniles/larvae <20 mm SL by the CWP, CVP, OMR flow, North Bay Aqueduct Barker Slough Pumping Plant and other small diversion systems is not considered here. Estimates of entrainment are highly uncertain because monitoring of entrainment of fish that size is limited and there are no related statistical models.

3.1.5 CDWF 2081(b): Delta Smelt questions

Question 4A: In the analysis of CWF construction and operational effects, how appropriate are beach seine surveys from the Delta Juvenile Fish Monitoring Program and Freeport diversion monitoring data (ICF 2015), in which Delta Smelt have been observed as by-catch, to characterize the proportion of the total Delta Smelt population in the vicinity of the north Delta diversions? Could these datasets be analyzed differently to better support the effects analysis?

The beach seine surveys do appear to be appropriate for assessing the relative distribution of Delta Smelt within the Sacramento River, although beach-seine deployment is largely limited to shorelines where there is minimal chance of snagging on subsurface obstructions, and thus the beach-seine data are less representative of more typical shoreline types within the river The style and specifications of the beach seine are appropriate for Delta Smelt; the net is a center-bag style that is 15.2 m long and 1.3 m high, with 0.3 cm square stretched mesh. Given its vertical height limitation, the beach seine is generally deployed in waters less than 1 m deep. Net deployment at the shoreline is appropriate for relevance to the NDD. The nets are deployed throughout the year. The geographic range of deployment extends long distances upstream and downstream of the NDD and includes a reasonable number of stations throughout the legal Delta as well as upstream reaches of the Sacramento and San Joaquin Rivers and downstream areas in Suisun, San Pablo, and San Francisco Bays. The September 9, 2014 metadata file (https://www.fws.gov/lodi/juvenile_fish_monitoring_program/jfmp_index.htm) states that 58 stations are currently in use. During the period 2012-2016, Delta Smelt were encountered in 231 beach-seine deployments, yielding 363 individuals (Table 2).

Table 2. Comparison of recent (2012-2016) beach-seine catches of Chinook and selected fish species that are associated with the Pelagic Organism Decline (*sensu* Mac Nally et al. 2010), where *Count* is frequency of encounter (number of seine deployments with non-zero catch) and *Sum* is the total number of individuals collected (data source: https://www.fws.gov/lodi/juvenile_fish_monitoring_program/jfmp_index.htm).

Species	*Count*	*Sum*
Chinook Salmon	1,723	59,423
Delta Smelt	98	363
Longfin Smelt	2	3
Rainbow Trout	59	88
Splittail	719	13,466

The analysis of the seine data in the application (Table 4.1-6) was straightforward, but could be improved. The proportion of Delta Smelt caught in the NDD area vs downstream was determined for individual years (1977 to 2011), and a mean of 18% of catch was calculated. Because total catches per year were often <5 individuals, the calculated proportions were often highly imprecise. This imprecision can be overcome by grouping years together. A multi-year bootstrapping approach could be used to estimate probabilities for use in the impingement estimate.

Another uncertainty that should perhaps as a high-priority research initiative under the Adaptive Management Framework is the representation of the beach seine monitoring sites in assessing Delta Smelt distribution, life history patterns, and habitat utilization. The beach seine surveys are almost entirely positioned at locations were beach seines can be efficiently deployed, were there is minimal chance of snagging on subsurface obstructions. The result is that these monitoring data are likely representative of Delta Smelt occurrence and life history stage in clean beaches and boat ramps, but inadequately characterize the majority of habitat types across the Delta, and particularly where vegetation and natural (woody) debris and dense tidal wetlands inhibit deployment of a beach seine. Thus, while the beach seine data for Delta Smelt may correlate of the data from other aquatic ecosystems in the Delta, there is insufficient data to verify that assumption. The alternative concept—that Delta Smelt are distributed very heterogeneously in space and time according to the diversity of their aquatic habitats—is not testable with the beach seine monitoring. This may be more consequential given the high uncertainty about the habitats occupied by Delta Smelt during critical stages, e.g., spawning, that would be required for mitigation to effectively compensate for CWF effects with habitat restoration.

3.1.6 CDWF 2081(b): Chinook Salmon questions

Question 5A: How well does the effects analysis evaluate new adverse effects on salmonid species due to north Delta operations and changes in south Delta operations?

The CWF ITP presents findings from a number of available approaches for evaluating potential effects of PA operations on salmon survival. A tremendous amount of detail is presented and the findings are presented objectively. Although detail is appreciated, it also made it difficult to fully evaluate merits of the various analyses. While there is some commentary on the merits of various approaches, often the findings are simply presented without such commentary. Uncertainty in PA effects is frequently highlighted when presenting findings from the detailed analyses. However, uncertainty and potential bias from using surrogates (e.g., large hatchery yearling fall Chinook Salmon) in modeling intended to encompass diverse life histories is likely underestimated in the quantitative uncertainty estimates in the salmon analyses.

Comments on the Potential to Jeopardize Continued Existence of the Species

The concluding statements regarding levels of take and the potential of the PA to jeopardize the continued existence of the salmon species (e.g., Sections 4.3.8.3 and 4.4.8.3) do not describe the high uncertainty nor the level of potential adverse impacts to salmon that are presented in the main text. This summary sections seems to be a significant departure from information presented in the detailed sections. The CWF ITP concludes, *"it is generally not possible to quantify numbers of individuals that may be taken incidental to the many components of the proposed project. However, the overall potential for take is low. The covered activities, facilities, and changes in operations associated with the new facilities have a low likelihood of resulting in persistent changes in mortality of individuals. Habitat losses would be relatively small—~50 acres as a result of construction and 0.42 acres as a result of operational effects on channel margin benches (Table 5.4-1 in Chapter 5 Take Minimization and Mitigation Measures)—and are not expected to have a population-level effect." "Mitigation is expected to fully offset habitat loss and any loss of individuals because high-quality, larger-scale, intact habitat will be acquired, enhanced, and managed in perpetuity; see Section 5.4.3 Sacramento River Winter-Run Chinook Salmon of Chapter 5 Take Minimization and Mitigation Measures. Thus, the PP fully mitigates for the potential incidental take of winter-run Chinook salmon."* There are other examples in this section of the CWF ITP that inappropriately minimize the potential effects of the PA on salmonids.

The conclusion seems to stem from several significant assumptions. Firstly, there seems to be an assumption that reduced exports from the South Delta under the PA would offset mortality of salmon associated with water diversion at the NDD. This key assumption seems to be based on the uncertain findings of the OBAN model, which is influenced by simple assumptions that the PA reduced survival through the delta by 1%, 5%, 10% or 50%. In contrast to this apparent assumption in the Take conclusions, the reported incidental take of winter-run juvenile Chinook Salmon entrained at the South Delta pumps has averaged only 0.55% of the juvenile production entering the delta (range 0.0-1.3%) (Appendix Section 5.D.1.1.2); similar estimates for spring run Chinook Salmon are not available. The 95% probability intervals for the Export function in the OBAN model included both negative and positive values, indicating the uncertainty in the effect of this key variable, but this is not mentioned in the concluding statements.

The Take conclusions did not discuss or refute alternative findings that were presented in the main text. For example, the IOS life cycle model suggested significant adverse effects of the PA compared with the NAA. The IOS model indicated approximately 25% fewer winter run Chinook Salmon spawners under the PA compared with NAA (median of all years; prediction intervals show consistently lower salmon escapement under the PA). During dry and critical water years, the cumulative effects of the PA were predicted to cause a 30-70% reduction in spawning Chinook salmon (Fig. 5-D-150). The IOS and OBAN findings (and findings from other models) did not consider potential reductions in salmon mortality associated with real time operation management and other measures, therefore it is difficult to quantitatively evaluate the effectiveness of these measures in reducing potential impacts of the PA. Nevertheless, the concluding statements assume these and other actions would fully mitigate adverse effects on salmon.

Secondly, the Take conclusions did not address uncertainty associated with the amount of habitat restoration required to mitigate for 50 acres of habitat disruption during construction and 0.42 acres of habitat disrupted by project operations. Habitat will be mitigated using a 3:1 ratio of "restored" to disrupted habitat. The CWF ITP estimates that only 0.42 acres of habitat would be disrupted by PP operations. This mitigation value is based on inundation of shallow wetland and riparian bench habitats, which were influenced relatively little by the diversion of up to 40% of Sacramento River inflow in some months and water years (e.g., November, below normal year). This analysis and the associated mitigation (3 x 0.42 acres of habitat) were apparently independent of effects from the percentage of Sacramento River water and sediments that will be diverted, and the effect of NDD operations on salinity, sedimentation, and wetland vegetation across the delta. Salinity, water depth, velocity, and vegetation are important factors contributing to salmon rearing habitat in the estuary. The quality and quantity of habitats available for Chinook Salmon and Steelhead in the Delta depend on inflows from the Sacramento River (del Rosario et al. 2013). Both short-term and long-term effects of water diversion on salmon habitat should be considered. The spatial distribution and density of rearing juvenile salmonids in the delta was not described, so it is difficult to assess how water diversion will affect habitats that currently support high rearing densities.

Thirdly, the PA identified a number of take minimization measures (Chapter 5),),, such as construction work windows, pulse flows during NDD operations, and real time operations management. These actions should be help reduce potential adverse impacts, but there is uncertainty in how effective the measures will be. For example, as discussed below, pile driving will be limited to June 1 through October 31 in order to avoid most salmonids, but some winter and spring Chinook salmon will likely be present and, according to the analyses presented in the CWF ITP, noise levels from impact hammering will be sufficient to injure salmon when present in the construction area. Less harmful methods will be used to install pilings when possible, but the tremendous number of piling indicates considerable impact hammering will be needed to install pilings. These potential impacts did not appear to be mitigated.

Therefore, the concluding statement, "*Thus the PP fully mitigates for the potential incidental take of winter-run Chinook salmon.*" underestimates potential adverse impacts on winter- and spring-run Chinook Salmon in response to PA construction and operations. Furthermore, as noted above, the conclusions simply assume that future climate change will have the same effect on salmon under the PP and the NAA even though some of the modeling results indicate greater negative impacts under the PP during dry versus wet years. The CWF ITP should justify why it seemingly relies on some findings more than others.

Question 5B: Are the analyses of take by life stage and water year type scientifically sound? How useful are these analyses for determining annual population impacts?

An approach that examines potential impacts of the PA by life stage of salmon is appropriate because it helps to identify the mechanism of how the PA might affect salmon. These findings can then be used to rectify or mitigate for the adverse effect, if present.

However, it is also critical to evaluate <u>cumulative effects</u> of the PA on salmon survival and viability. This is because effects during each life stage may be small and less apparent, whereas cumulative effects across all relevant life stages may identify impacts that are important to viability.

Construction Effects

The main text described the potential impacts to juvenile and adult salmon caused by impact pile driving in the delta, but these potential adverse effects were not considered in the Take conclusions. Pile driving noise effects on juvenile and adult salmon is expected to be minimized by using vibration rather than impact hammer driving when soil condition are suitable, and by restricting pile driving to June 1 to October 31, a period when fewer juvenile and adult Chinook salmon are present.. Clarification is needed to better document the migration timing of adult winter-run and spring-run Chinook salmon as they migrate through Delta reaches where impact pile driving will occur. For example, some reports indicate adult spring-run Chinook salmon enter the Sacramento River primarily in May and June and continue to enter the watershed through September (NOAA BO, Section 2.4, P. 7). A tremendous number of piles will be installed and the report indicates ~30% of each pile may be installed by impact hammer. The report noted the potential use other minimization measures such as dewatering and bubble curtains. However, the main text indicated noise produced by the impact hammer exceeded thresholds for injuring salmon up to 3,280 ft away (if no obstructions) or causing a behavioral response up to 32,800 ft (6.2 miles), assuming no obstructions such as bends in the river (e.g., Table 4.3-2). At Clifton Court Forebay, *"Pile driving operations include the installation of an estimated 10,294 temporary sheet piles to construct the cofferdams for the embankments and divider wall, and 2,160 14-inch diameter concrete or steel pipe piles to construct the siphon at the NCCF outlet."* We were not able to find the total number of piles by type and size for the entire effort, but these values indicate a substantial number of piles to be installed. Some winter and spring Chinook are likely to be present in the Delta during pile driving, and some of these fish could encounter injurious decibels of sound during impact pile driving. Although the pile driving activity will avoid the period when most salmon are present, survival of salmon from the tail ends of the migration period is important for maintaining characteristics of viable salmon populations such as diversity and spatial structure.

Near-field Effects

The CWF ITP recognized uncertainty in whether predators might aggregate at the NDD and consume juvenile salmonids. The potential effect of increased predation at the NDD will be evaluated through compliance with a performance standard: *"maintain listed juvenile salmonid survival rates through the reach containing the NDD [0.25 miles upstream of the upstream-most intake to 0.25 miles downstream* *of the downstream-most intake] of 95% or more of the existing survival rate in this reach."* A quantitative performance standard such as this is a good approach for ensuring that predators do not have a greater impact than anticipated at the NDD. Actions to offset unexpectedly high mortality in this reach should be developed in the Adaptive Management Plan.

Less mortality of salmon is expected via exports at the south delta facilities, especially in wet years when a higher percentage of water is diverted via the NDD. It is critical to consider the population level effect of exports on salmon through the South Delta pumps when evaluating water diversion from the South Delta versus the NDD. The CWF ITP noted that the reported incidental take of winter-run juvenile Chinook Salmon entrained at the South Delta pumps has averaged 0.55% of the juvenile production entering the delta (range 0.0-1.3%) (Appendix Section 5.D.1.1.2); however, similar estimates for spring run Chinook Salmon are not available. Population level effects under current conditions identifies the limit to which reduced exports through the South Delta might benefit winter run Chinook salmon.

Water Facility Operation Effects

A life cycle model is a key tool for incorporating and assessing cumulative effects, including future climate change effects. Life cycle models incorporate survival functions at key life stages in a framework that allows impacts to be accumulated across the life cycle and then passed on to the next generation. Two life cycle models were described in the CWF ITP: IOS and OBAN. A careful review of these models is beyond the scope of this effort and further detailed documentation of the models and data would be needed. The IOS life cycle model is an example where PA effects by life stage were relatively small. However, significant adverse effects were detected when cumulative effects were examined by looking at spawning abundances, i.e., the life stage that reflect all previous mortality. For example, the PA was predicted to produce 25% fewer spawning salmon across all years (median) compared with the NAA. Spawning abundance declined to 30-70% in dry and critical water years. In contrast, the OBAN model predicted less adverse effects of the PA. The CWF ITP should evaluate the strengths and weaknesses of these two models, which indicate very different PA effects. For survival through the Delta, the IOS model relied upon the Delta Passage Model. In contrast, the OBAN model assumed the NDD caused a reduction in delta survival from 0.1 to 0.5. As noted above, conclusions about take on salmon seemed to rely upon the OBAN model while not mentioning the findings from the IOS model.

Some analyses in the CWF ITP seem to be based on outdated information. For example, some CWF ITP analyses relied upon laboratory studies to evaluate the effect of water temperature in the Sacramento River on eggs survival, but Martin et al. (2016) reported that these laboratory studies underestimated egg mortality in the river. Also, the Delta Passage Model is a key tool for evaluating the effects of the PA on salmon survival in the delta, but the underlying data may not be as complete as it could be. The Delta Passage Model is based on the tagging of large hatchery yearling fall Chinook salmon and the CWF ITP notes that these data may not reflect survival of much smaller winter and spring run Chinook Salmon that use the estuary differently from larger smolts (this observation was not considered in the conclusions)(see size information presented in answer to Question 2C-Part A & B. Michel et al. (2015) noted that mortality of other Chinook races is likely greater than that of the tagged hatchery salmon because they are smaller and more vulnerable to predators. A number of new survival studies have been completed in recent years and those data should be incorporated into the Delta Passage Model and IOS model. As discussed above (Question 2C-Part B), additional research on the use of the Delta by smaller Chinook salmon is needed.

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None of the modeling results considered the long-term effect that water diversion at the NDD would have on salmon habitat quantity and quality in the Sacramento River Delta. A considerable volume of water will be diverted from the NDD during some months and water years. This diversion will influence the distribution of salinity and sedimentation, distribution of wetland vegetation, and the distribution of rearing salmonids. Short-term effects of water diversion on dewatering of wetland and riparian habitats were estimated at select benches, but the CWF ITP analysis did not consider all mechanisms of how water diversion may impact rearing salmon, as noted above in Question 5A. Juvenile salmon rear and grow in the delta for extended times, and habitat quality and quantity are important to their survival.

Predation is a key source of mortality for ESA-listed fishes in the Delta. For example, non-native Striped Bass, a popular sport fish, is a significant predator on juvenile Chinook Salmon in the Delta (Lindley and Mohr 2003) and reduced flow may increase predation on salmon (Cavallo et al. 2013). Lindley and Mohr (2003) reported that entrainment at the South Delta water diversion facilities and ecosystem changes have reduced the carrying capacity for subyearling Striped Bass, and have contributed to their decline from the 1960s to 1996. However, this trend could be reversed if the PA does indeed reduce entrainment at the South Delta facilities. The CWF ITP did not address this issue, but ICF consultants noted that some earlier information (Impact AQUA-201, Impact Aqua-203) may contain relevant information to be considered in the BiOP. These documents were not readily available to the Panel.

Panel Comments on Cumulative System Effects

The Panel recognizes that this 2081 (b) application is designed as species-level and life-stage-specific analyses, appropriate for maximal protection of CESA listed species. However, by taking this narrow approach, the analysis ignores that many of these species directly or indirectly interact over common Delta and Bay ecosystems and that their vulnerability to PP effects may be a function of cumulative effects of the project on Delta processes. That many of the 2081 (b) analyses identify the potential responses of individual species to PP alterations to the Delta are contingent on changes in hydrology, salinity, turbidity and other Delta-scale processes implies that there will be trade-offs in planning and managing for minimal incidental take among the three fish species, if not some of the other listed species as well. The Panel suggests that cumulative, Delta-scale ecosystem effects of the PP need to be evaluated in the context of multiple overlapping and interacting populations of at-risk species. Examples of cumulative or collateral, large-scale effects would include, but not be limited to, PP effects on: (1) tidal hydrology; (2) mitigation responses; and, (3) suspended sediment diversion.

<u>Tidal Hydrology</u>. The complicated interactions among river flow, tides, shifts in salinity and shallow habitats with proposed North Delta diversions were not effectively modeled or interpreted at the scale of the interconnected Delta. Smaller life history stages of the listed fish, their prey and predators utilize shallow, brackish water in the Delta but it is unclear to the Panel how they would collectively differ in their responses to the proposed NDD scenarios. CalSim II hydrodynamic modeling is effectively used to evaluate likely environmental responses to the PP such as the X2 position. However, we cannot determine whether or how the effects of the seasonally-dependent PP diversion scenarios consider the frequency and flooding of spawning, rearing and foraging habitats of the different species in different regions of the Delta. For example, how does the removal of up to 40% of the river water (hydrograph

provided to the panel) in some months under the 2081 (b) permit likely affect vegetation (high marsh, riparian) and associated habitat, secondary productivity, and turbidity in different down-estuary segments?

Mitigation Responses. Mitigation of long-term incidental take associated with project operations is not specifically addressed on a Delta-wide scale, yet the responses to large mitigation actions (e.g., breaching/removing levees for tidal wetland restoration) will vary appreciably depending on the region of the Delta that the mitigation action is occurring and where the response is manifested. As evidenced by hydrodynamic modeling of Suisun Bay and the Delta , the location and volume of increases in tidal prism that are likely to be represented by tidal wetland restoration will dictate changes in the tidal range—and thus elevation, frequency and duration of tidal flooding—of other segments of the Delta. At the November 2009 Ecosystem Restoration at the Landscape Scale: North Delta and Suisun Marsh Workshop sponsored by the Science Program, Chris Enright (DWR) and Jon Burau (USGS/Sacramento) both illustrated that restoration tidal marsh in Suisun Bay will dissipate tidal energy. As a result, the distance the tidal signal propagates into the interior Delta is reduced. Jon Burau recommended in that workshop, and again at the 2016 Bay Delta Science conference, that restoration efforts should be developed starting from the west (Suisun Bay) to the Northeast because there is a limited amount of tidal energy that can be distributed to these restoration efforts. (Science Program Workshop 2009)(http://www.science.calwater.ca.gov/events/workshops/workshop_eco.html) For instance, breaching of levees to restore historic tidal wetlands in the lower portion of the system (e.g., Suisun Marsh) as mitigation for post-larval and juvenile Longfin Smelt rearing habitat would likely result in depressed tidal flood regime in the northern Delta, potentially impacting the existing access of juvenile salmon to their tidal wetland rearing habitats, or the potential for similar tidal restoration actions in that region. Because the existing mitigation planning is unspecific about the design and location of these mitigation actions, there is no feasible way to assess the potential large-scale, site-specific impact of the PP.

Sediment Starvation. It has been estimated that the Bay-Delta's tidal wetlands will require a total sediment input of over 10 $Mm^3\ yr^{-1}$ (2.6 cm yr^{-1}) to keep pace with the higher projections of sea level rise, over twice as much as is currently being deposited (Barnard et al. 2013; DredgeFest 2016 report). It appears that the applicants have failed to analyze the effect of the 10% suspended-sediment (fines) loss due to NDD operations. It is encouraging to note that "*Sacramento River sediment removed from the water column by the NDDs will be reused as described above. However, to the maximum extent practicable, the first and preferred disposition of this material will be to reintroduce it to the water column in order to maintain Delta water quality*." (3.2.10.6). However, based on the NDD sedimentation basins design to "*capture sand-sized sediment and drying lagoons for sediment drying and consolidation*" (ICF 3.2.2.1), the Panel would interpret that only the coarse (sand and larger particle sizes) will be retained, and that suspended fines (silt and clay particles) will be lost to the NDD to the south Delta.

Furthermore, the Panel's concern about the uncertainty around potential sediment starvation by the NDD diversion of 7-16% of the Sacramento River load at Freeport that we expressed in the Phase 1 report (see Phase 1- Appendix 7) has not been addressed. The primary response is: "*DWR will* *collaborate with USFWS and CDFW to develop and implement a sediment reintroduction plan that provides the desired beneficial habitat effects of maintained turbidity while addressing related permitting concerns (the proposed sediment reintroduction is expected to require permits from the Water Control Board and USACE). This would minimize the effects of sediment removal by the NDD. "* [ICF, 2016: 00408.12 5.3.2.3.1] There is an expressed uncertainty about where they would introduce the 'recycled' sediment but no information on the volume and sediment structure, that might be recovered from the sediment removed at the NDD intakes.

4 Acknowledgments

<to be done>

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5 References

Armitage et al. 2015, 241

Barnard, P.L., D. H. Schoellhamer, B.E. Jaffe, and L.J. McKee. 2013. Sediment transport in the San Francisco Bay coastal system: An overview. Mar. Geol. 345:3-17.

Benson, M.H., D. Llewellyn, R. Morrison, M. Stone. 2014. Water governance challenges in New Mexico's Middle Rio Grande Valley: a resilience assessment. *University of Idaho Law Review* 51: 196-228.

Benson, M.H. and C. Schulz. 2015. Adaptive management and law. In C.R. Allen and A.S. Garmestani (eds.) *Adaptive Management of Social-Ecological Systems*, pp. 39-59. New York: Springer.

Birge, H.E., C.R. Allen, R.K. Craig, A.S. Garmestani, J.A. Hamm, C. Babbitt, K. Nemec, E. Schlager. 2014. Social-ecological resilience and law in the Platte River Basin. *University of Idaho Law Review* 51: 229-256.

Brown, L.R., L.M. Komoroske, R.W. Wagner, T. Morgan-King, J.T. May, R.E. Connon, and N.A. Fangue. 2016. Coupled downscaled climate models and ecophysiological metrics forecast habitat compression for an endangered estuarine fish: PlosONE 11(1):e0146724. doi: 10.1371/journal.pone.01467240146724

Cavallo, B., J. Merz, and J. Setka. 2013. Effects of predator and flow manipulation on Chinook salmon (*Oncorhynchus tshawytscha*) survival in an imperiled estuary. Environ Biol Fish 96:393–403.

Center for Biological Diversity v. Rumsfeld 2002

Delta Stewardship Council Workshop. November 2009. Ecosystem Restoration at the Landscape Scale: North Delta and Suisun Marsh Workshop. (http://www.science.calwater.ca.gov/events/workshops/workshop_eco.html)

Del Rosario, R. B., Y. J. Redler, K. Newman, P. Brandes, T. Sommer, K, Reece, and R. Vincik. 2013. Migration patterns of juvenile winter-run-sized Chinook Salmon (*Oncorhynchus tshawytscha*) through the Sacramento–San Joaquin Delta. San Fran. Est. Watershed Sci. 11. :1-22. (http://escholarship.org/uc/item/36d88128Grimaldo, L. F, in review

Haskell, W.L. 1959. Diet of the Mississippi threadfin shad, *Dorosoma petenense* atchafalayae, in Arizona. Copeia1959:298-302.

ICF. 2016. Adaptive Management Framework for the California Water Fix and Current Biological Opinions on the coordinated operations of the Central Valley and State Water Projects. 75 pp.

Independent Scientific Advisory Board (ISAB). 2015. Density dependence and its implications for fish management and restoration programs in the Columbia River Basin. ISAB Document 2015-1. Prepared for the Northwest Power and Conservation Council. http://www.nwcouncil.org/fw/isab/

Kimmerer, W. J. 2002. Effects of freshwater flow on abundance of estuarine organisms: physical effects or trophic linkages? Mar. Ecol. Prog. Ser. 243: 39-55.

Kimmerer, W. J., E. S. Gross, and M. L. MacWilliams. 2009. Is the response of estuarine nekton to freshwater flow in the San Francisco estuary explained by variation in habitat volume? Est. Coasts 32:375-389.

Kimmerer, W.J., 2013

Lindley, S. and M. Mohr. 2003. Modeling the effect of striped bass **(***Morone saxatilis***)** on the population viability of Sacramento River winter-run Chinook Salmon **(***Oncorhynchus tshawytscha***)**. Fishery Bulletin 101:321**–**331.

Mac Nally, R., J. R. Thomson, W. J. Kimmerer, F. Feyrer, K. Newman, A. Sih, W. A. Bennett, L. Brown, E. Fleishman, S. D. Culberson, and G. Castillo. 2010. Analysis of pelagic species decline in the upper San Francisco Estuary using multivariate autoregressive modeling (MAR). Ecol. Appl. 20:1417-1430.

Martin, B.T., A. Pike, S.N. John, N. Hamda, J. Roberts, S.T. Lindley, and E.M. Danner. 2016. Phenomenological vs. biophysical models fo thermal stress in aquatic eggs. Ecology Letters doi: 10.1111/ele.12705

MAST (Management, Analysis, and Synthesis Team). 2015. An updated conceptual model of Delta Smelt biology: Our evolving understanding of an estuarine fish. Interagency Ecological Program for the San Francisco Bay/Delta Estuary, Technical Report 90

Maunder, M. N., R. B. Deriso, and C. H. Hanson. 2015. Use of state-space population dynamics models in hypothesis testing: advantages over simple log-linear regressions for modeling survival, illustrated with application to Longfin Smelt (*Spirinchus thaleichthys*). Fish. Res. 164:102-111.

Michel, C. J., A. J. Ammann, S. T. Lindley, P. T. Sandstrom, E. D. Chapman, M. J. Thomas, G. P. Singer, A. P. Klimley, and R. B. MacFarlane. 2015. Chinook salmon outmigration survival in wet and dry years in California's Sacramento River. Canadian Journal of Fisheries and Aquatic Sciences 72(11):1749–1759.

Miller JA, Gray A, Merz J. 2010. Quantifying the contribution of juvenile migratory phenotypes in a population of Chinook Salmon *Oncorhynchus tshawytscha*. Marine Ecology Progress Series 408: 227–240.

Mount J., Fleenor, B. Gray, B. Herbold, and W. Kimmerer. 2013. Panel Review of the draft Bay-Delta Conservation Plan. Prepared for the Nature Conservancy and American Rivers. September. Saracino & Mount, LLC, Sacramento, CA.

Nobriga, M. L., and J. A. Rosenfield. 2016. Population dynamics of an estuarine forage fish: disaggregating forces driving long-term decline of Longfin Smelt in California's San Francisco Estuary. Trans. Am. Fish. Soc. 145:44-58.

Rose, K., J. Anderson, M. McClure, and G. Ruggerone. 2011. Salmonid integrated life cycle models workshop. Report of the Independent Science Panel prepared for the Delta Science Program, CA.

Runge (201x)

Ruhl, J.B. and R.L. Fischman. 2010. Adaptive management in the courts. *Minnesota Law Review* 95: 424-484.

Schoellhamer, D.H., S.A. Wright, and J.Z. Drexler. 2013. Adjustment of the San Francisco estuary and watershed to decreasing sediment supply in the 20th century. Marine Geology 345:63–71. http://dx.doi.org/10.1016/j.margeo.2013.04.007.

Schultz, C. and M. Nie. 2012. Decision making triggers, adaptive management, and natural resources policy and planning. *Natural Resources Journal* 52:443-521.

Stern, C.V., P.A. Sheikh, and C.T. Brass. 2011. *Adaptive Management for Ecosystem Restoration: Analysis and Issues for Congress*. Congressional Research Service, Washington D.C.

Sturrock, A.M., J.D. Wikert, T., Heyne C., Mesick A.E., Hubbard T.M., Hinkelman et al. 2015. Reconstructing the migratory behavior and long-term survivorship of juvenile Chinook salmon under contrasting hydrologic regimes. PLoS ONE 10(5): e0122380. doi:10.1371/journal.pone.0122380

Swanson, K. M., J. Z. Drexler, C. C. Fuller, and D. H. Schoellhamer. 2015. Modeling tidal freshwater marsh sustainability in the Sacramento-San Joaquin Delta under a broad suite of potential future scenarios. San Fran. Est. Watershed Sci. 13 *doi:* http://dx.doi.org/10.15447/sfews.2015v13iss1art3

Thomson, J. R., W. J. Kimmerer, L. R. Brown, K. B. Newman, R. Mac Nally, W. A. Bennett, F. Feyrer, and E. Fleishman. 2010. Bayesian change point analysis of abundance trends for pelagic fishes in the upper San Francisco Estuary. Ecol. Appl. 20:1431-1448.

USFWS (United States Fish and Wildlife Service). 2008. Formal Endangered Species Act consultation on the proposed coordinated operations of the Central Valley Project (CVP) and State Water Project (SWP). U.S. Fish and Wildlife Service, Sacramento, CA.

USFWS and NMFS. 1998. Endangered Species Act Consultation Handbook: Procedures for Conducting Section 7 Consultations and Conferences https://www.fws.gov/ENDANGERED/esa-library/pdf/esa_section7_handbook.pdf

Weitkamp, L. A., G. Goulette, J. Hawkes, M. O'Malley, and C. Lipsky. 2014. Juvenile salmon in estuaries: comparisons between North American Atlantic and Pacific salmon populations. Review in Fish Biology and Fisheries 24:713–736.

Wright, S. A., and D. H. Schoellhamer. 2005. Estimating sediment budgets at the interface between rivers and estuaries with application to the Sacramento–San Joaquin River Delta. Water Resource Res. 41(W09428). doi: http://dx.doi.org/10.1029/2004WR003753

Appendix 1 Biographies of CA WaterFix Aquatic Science Peer Review Panel Members

Charles "Si" Simenstad (Chair) Charles ("Si") Simenstad is a Research Professor in the University of Washington's School of Aquatic and Fishery Science, where he coordinates the Wetland Ecosystem Team. Prof. Simenstad is an estuarine and coastal marine ecologist who has studied the organization and function of estuarine and coastal marine ecosystems throughout Puget Sound, Washington, Oregon and California coasts, and Alaska for over forty years. Much of this research has focused on the functional role of estuarine and coastal habitats to support juvenile Pacific salmon and other fish and wildlife, the associated ecological processes and community dynamics that are responsible for enhancing their production and life history diversity, and whether restoration of estuarine ecosystems can contribute to the recovery of depressed salmon populations. Si's most recent research focus is on developing and testing an estuarine ecosystem classification system for the Columbia River estuary, and employing it to delineate juvenile Pacific salmon habitat through the estuary gradient.

Prof. Simenstad is a Fellow of the American Association for the Advancement of Science, Co-Editor-in-Chief for Estuaries and Coasts, and Associate Editor for San Francisco Estuary & Watershed Science, Revue Paralia and the Encyclopedia of Puget Sound. He also serves on the Chief of the US Army Corps of Engineers Environmental Advisory Board and Washington Department of Natural Resources, Commissioner of Public Lands' Expert Council on Climate & Environmental Change. He has authored or co-authored 85 peer-reviewed scientific papers, 22 book and proceedings chapters, 34 miscellaneous publications and >125 workshop proceedings and technical reports. He has served as academic advisor for 32 M.S./Ph.D. graduate students, and served on an additional ~47 graduate student committees. Si holds a B.S. (1969) and M.S. (1971) from the School of Fisheries at the University of Washington.

John Van Sickle, Ph.D. (Lead Author, Phase 1) Dr. Van Sickle is a consulting environmental statistician, recently retired from the U.S. Environmental Protection Agency's Office of Research and Development. Since 1998, his research has focused on the monitoring and assessment of freshwater ecosystems, with an emphasis on indicators of health for multispecies biological assemblages, and on estimating the risks of aquatic stressors to biota. Prior to 1998 Dr. Van Sickle taught and did research in systems modeling, mathematics, statistics and ecology at Oregon State University and the University of Zimbabwe. Dr. Van Sickle earned his B.S. and M.S. in mathematics, and his Ph.D. in systems science, from Michigan State University, and also received an M.S. in statistics from Oregon State University.

Nancy Monsen, Ph.D. (Lead Author, Phase 2) Dr. Monsen's research has focused on multi-dimensional hydrodynamic modeling of the SacramentoSan Joaquin Delta and Suisun Bay for the last twenty years. Her Ph.D. research was based on the TRIM3D hydrodynamic model and recently she has been working on Stanford's SUNTANS hydrodynamic model. She also has consulting experience with the DELFT3d hydrodynamic model. Nancy Monsen joined Stanford University in August 2011, having worked previously with Philip Williams & Associates, Ltd. (now ESA PWA) and the U.S. Geological Survey (USGS). Funding for her Stanford research ended in August 2014 but she continued part-time as a visiting scholar at Stanford until August 2015, writing papers and assisting current PhD candidates and Post-Doctoral researchers in the Environmental Fluid Mechanics Laboratory. She has recently been on several science review panels including the Independent Review of the Draft Bay Delta Conservation Plan Effects Analysis (2014), the State of the Science Workshop on Fish Predation on Central Valley Salmonids in the Bay-Delta Watershed (2013), and the Independent Review Expert Science Panel of the Collaborative Adaptive Management Team (CAMT) Proposed Investigations on Understanding Population Effects and Factors that Affect Entrainment of Delta Smelt at the State Water Project and Central Valley Project (2014). Dr. Monsen earned her doctorate in Civil and Environmental Engineering at Stanford University.

Hannah Gossnell, Ph.D. Dr. Hannah Gosnell is an Associate Professor of Geography in the College of Earth, Ocean, and Atmospheric Sciences at Oregon State University. Her research focuses on agricultural landscape change, water resource management, climate change and environmental governance in the context of rural working landscapes; and how laws and institutions might evolve to better reflect changing geographies and facilitate social-ecological transformation when necessary. Her PhD research focused on implementation of Section 7 of the Endangered Species Act and the development of a Reasonable and Prudent Alternative for the Animas-La Plata Project in the Colorado River Basin. Previous research also includes an examination of social and institutional processes leading to the development of the Klamath Basin Restoration Agreement and the Klamath Hydroelectric Settlement Agreement in 2010. A member of the Resilience Task Force of the IUCN Commission on Ecosystem Management, Dr. Gosnell has authored or co-authored over 40 peer-reviewed scientific articles and was Associate Editor for Rangeland Ecology & Management. She has served as a social scientist on several scientific review panels for the National Science Foundation's Long Term Ecological Research (LTER) program and is the Lead Social Scientist at the H.J. Andrews Experimental Forest LTER Program. She is currently a member of the Adaptive Water Governance Project funded by NSF's Socio-Environmental Synthesis Center and a Fellow at Colorado State University's Center for Collaborative Conservation. She was the 2015 recipient of the Quivira Coalition's Radical Center Research Award for "remarkable and enduring leadership in the difficult job of working in the radical center - the place where people are coming together to explore their common interests rather than argue their differences." Dr. Gosnell earned MA and PhD degrees in Geography from the University of Colorado, and a BA in American Civilization from Brown University.

Ernst Peebles, Ph.D. Dr. Ernst Peebles is a professor of Marine Science at the University of South Florida. He received his Bachelor's degree from Tulane University in his native New Orleans, and his Master's and doctoral degrees from USF in Tampa. After receiving his doctoral degree, Dr. Peebles worked as summer faculty at the Gulf Coast Research Laboratory in Ocean Springs, Mississippi, and also served as adjunct graduate faculty at Florida Gulf Coast University in Ft. Myers, Florida. His 82 publications reflect more than thirty years of experience working with dynamic coastal fish and shellfish habitat, with an emphasis on freshwater inflow effects, life history, and biomass pathways. Dr. Peebles and his students are currently developing a new method for reconstructing the geographic and food-web histories of individual fish using stable-isotope records that are stored within fish eye lenses.

Gregory Ruggerone, Ph.D. Dr. Greg Ruggerone has investigated population dynamics, ecology, and management of Pacific salmon in Alaska and the Pacific Northwest since 1979. He was Project Leader of the Alaska Salmon Program, University of Washington, from 1985-1993, and he continues to supervise graduate student research in Alaska. Most of his research involves factors that affect growth, age at maturation, and survival of salmon in freshwater and marine habitats (http://www.researchgate.net/profile/Gregory_Ruggerone/contributions).).). For the past 10 years, he has evaluated management of salmon fisheries in Russia, Alaska, British Columbia and California for sustainability using Marine Stewardship Council criteria. He recently served as the fish ecologist on the Secretary of Interior review of dam removal on the Klamath River. He is past-Chair of the Columbia River Independent Scientific Advisory Board (after serving the maximum 6 year term) and member of the Independent Scientific Advisory Board.

Appendix 2 Phase 2a Charge to Panel

The panel will review 1) the draft adaptive management framework for CWF and Current Biological Opinions on coordinated operations of the CVP and SWP and 2) the 2081(b) application analyses of the CWF impacts of take for Winter-run Chinook, Spring-run Chinook, Delta Smelt, and Longfin Smelt. Since these items will provide the basis of the 2081(b) permit, the reviewers should evaluate whether the items are sufficiently robust and at a level of scientific quality to serve their intended purposes. The Panel members will have at least 30 days to familiarize themselves with the materials.

The Panel will also be given relevant background information to consider and will receive presentations from the relevant agencies at the public meeting.

Specific questions for review of the CWF Adaptive Management Framework (Framework) and analyses of Winter and Spring- run Chinook, Delta Smelt, and Longfin Smelt presented in the 2081(b) permit application:

1. *Are the compliance monitoring, collaborative science, and adaptive management approaches outlined in the Adaptive Management Framework appropriate for addressing the uncertainties associated with the implementation of CWF, specifically related to CWF operations in conjunction with the SWP and CVP facilities? In answering this question, consider the following:*

    - Does the Framework adequately reflect comments and issues raised in Phase 1 of this review?
    - Is the Framework sufficient to address the uncertainties associated with the current analyses and provide a timely mechanism for addressing future changes in operations based on new understanding of listed species distribution and abundance?
    - How well does the Framework build off and incorporate existing adaptive management or related efforts?
    - Does the Framework adequately address areas or gaps not currently covered by existing efforts?
    - How thoroughly do the steps and decision making processes outlined in the Framework support its intent and objectives? Do the commitments to new research, monitoring, and modeling appropriately support the management component of the Framework?
    - Will the approaches to scientific research and monitoring allow robust and adequate documentation of effectiveness in reducing uncertainty associated with CWF and existing measures to minimize and mitigate impacts to species?
    - Will the approaches to scientific research, monitoring, and associated decision making allow for tracking the effects of CWF on populations of the four listed species over time and the effectiveness of management actions?

2. *To what extent are the analyses used for the CDFW 2081(b) permit application scientifically sound and their conclusions scientifically supported? In answering this question, consider the following:*

General

- Do analyses of CWF operations and impacts to species through 2060 resolve panel comments raised in Phase 1 of this review? Is climate change adequately incorporated into the cumulative analysis?
- The 2081(b) application currently utilizes long-term averages to analyze near and far field effects of CWF operations on habitat conditions. Does this approach adequately describe year-to-year effects of CWF on covered fish species' population dynamics? Are there alternative analytical approaches available that are more appropriate?
- Is the approach used to characterize take and associated impacts to covered fish species populations scientifically valid given current understanding and the recognized limitations of available analytical tools? Are there improvements to the current methods that could be implemented, or are there available alternative analytical approaches that are more appropriate for analyzing the extent of take and associated impacts to the species?
- Do the conclusions of the effects analyses for covered species adequately acknowledge and incorporate uncertainty as recommended in Phase 1 of this review?

Longfin Smelt

- Is the proposed approach to achieve the March through May spring outflow targets for Longfin Smelt likely to result in spring outflow equivalent to existing conditions?
- The relationship between outflow and Longfin Smelt abundance uses a six-month (January through June) averaging window (Kimmerer 2009). How well does the 2081 (b) application justify using a three month (March through May) averaging window to provide outflow targets and operational criteria during that period?

Delta Smelt

- In the analysis of CWF construction and operational effects, how appropriate are beach seine surveys from the Delta Juvenile Fish Monitoring Program and Freeport diversion monitoring data (ICF 2015), in which Delta Smelt have been observed as by-catch, to characterize the proportion of the total Delta Smelt population in the vicinity of the north Delta diversions? Could these datasets be analyzed differently to better support the effects analysis?

Winter- and Spring-run Chinook Salmon

- How well does the effects analysis evaluate new adverse effects on salmonid species due to north Delta operations and changes in south Delta operations?
- Are the analyses of take by life stage and water year type scientifically sound? How useful are these analyses for determining annual population impacts?

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Appendix 3 Materials for CA WaterFix Aquatic Science Peer Review – Phase 2a

Review Materials:

1. California WaterFix Adaptive Management Framework
   a. Cover Letter: Response to Panel Comments on California WaterFix Adaptive Management
   b. Adaptive Management Framework for the California Water Fix and Current Biological Opinions on the coordinated operations of the Central Valley and State Water Projects
      - Example of Process for Effecting and Adaptive Management Change under the Framework (In Appendix 7 of the Adaptive Management Framework)
2. Selected sections from the 2081(b) application:
   - Chapter 4
   - Introduction and 4.1: Take of Delta Smelt
   - 4.2: Take of Longfin Smelt
   - 4.3: Take of Sacramento River Winter-run Chinook Salmon
   - 4.4: Take of Central Valley Spring-run Chinook Salmon
   - 4.5: Take of the California Tiger Salamander
   - Chapter 5
   - Appendices
   - 2.A
   - 4.A
   - 4.D
   - 6.A (Adaptive Management Framework for the California Water Fix and Current Biological Opinions on the coordinated operations of the Central Valley and State Water Projects)
   - Example of Process for Effecting and Adaptive Management Change under the Framework (In Appendix 7 of the Adaptive Management Framework)

Supplemental Materials:

1. Relevant publications
   - Mount, J., W. Fleenor, B. Gray, B. Herbold, W. Kimmerer (2013) Panel review of the draft Bay Delta Conservation Plan. Prepared for The Nature Conservancy and American Rivers. Saracino and Mount, LLC, Sacramento, California, pp 66-69.
   - Kimmerer, W.J., E.S. Gross and M. MacWilliams (2009) Is the response of estuarine nekton to freshwater flow in the San Francisco Estuary explained by variation in habitat volume? Estuaries and Coasts 32: 375-389.
   - DFG (2009) Report to the Fish and Game Commission: A status review of the longfin smelt (*Spirinchus thaleichthys*) in California. Department of Fish and Game (DFG), Sacramento, CA.
   - 77 FR 19756 (2012) Endangered and threatened wildlife and plants; 12-month finding on a petition to list the San Francisco Bay-Delta population of the longfin smelt as endangered or threatened, Federal register 77:19756.

2. California Water Fix Biological Assessment Appendices:
   a. 5A
   b. 5B
      i. Attachment 1
      ii. Attachment 2
      iii. Attachment 3
      iv. Attachment 4

v. Attachment 5
c. 5C
d. 5D
i. Attachment 1
ii. Attachment 2
3. California Water Fix Biological Assessment Chapter 5

Supplemental Materials Requested by the Panel:

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  - Table of contents for the 2081(b) permit application
  - Response to Independent Review Panel Question 3
  - Responses to Independent Review Panel Request for Information Regarding Longfin Smelt Analysis Changes

Supplemental Materials Provided at the Review:

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  - Project Description from DWR's incidental take application for California WaterFix

Appendix 4 Agenda of Phase 2a Public Meeting

AGENDA Order of agenda items and listed times are subject to change

Day 1 (December 8, 2016)

I. Introduction

9:00 – 9:10 Welcome Remarks

9:10 – 9:40 Opening Remarks – NMFS, USFWS, CDFW

9:40 – 10:10 Responses to Panel's Phase 1 Comments – CDFW, ICF, and NMFS

10:10 – 11:00 California WaterFix Adaptive Management Framework – CDFW, NMFS, and DWR

11:00 – 11:45 Review Panel/ Presenter Q&A

11:45 – 1:00 Lunch

II. Analyses of Winter- and Spring-run Chinook, Delta Smelt, and Longfin Smelt presented in the California Department of Fish and Wildlife 2081(b) Permit Application

1:00 – 1:30 Modeling approach to providing spring outflow – CH2M

1:30 – 2:00 Longfin Smelt Analyses – ICF

2:00 – 2:30 Delta Smelt Analyses – ICF

2:30 – 3:00 Winter- and Spring-run Chinook Analyses – ICF

3:00 – 3:15 Break

III. General Presenter/ Review Panel Discussion

3:15 – 4:00 Review Panel/ Presenter Q&A

IV. Public Comment

4:00 – 4:15 Public Comment Period 4:15 Adjourn

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Appendix 5 Adaptive Management Recommendations from Phase 1 Report

<will be inserted in the final report>

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Appendix 6 Governance and Decision-making in other AM programs

<to be inserted in final version>

Appendix 7 Section on Sediment Starvation from Phase 1 Report (pp. 16-17)

"The Panel is concerned that NDD operations will increase the sediment starvation that is already occurring in the Delta (Schoellhamer et al. 2013), where approximately two-thirds of the sediment that enters the Delta is deposited in and sustains its marshes, sloughs, and mudflats. More than 80% of this sediment load originates from the Sacramento River, with the remainder from the San Joaquin River (Wright and Schoellhamer 2005). Therefore, it is important to consider not only how much sediment is exported from the Delta as a whole, but also consider whether there are critical habitats in the region of influence of that export site. Based on current water circulation patterns, the suspended sediment in the southern Delta has a low potential of being transported to the Cache Slough complex in the northern Delta, where large wetland restoration projects are being constructed. However, suspended sediment in the Sacramento River, where the proposed north Delta facilities will export water and sediment, is highly likely to be transported to the Cache Slough complex.

BA Appendix 3.B, Conceptual 1 Engineering Report, Volume 1, Section 6.1.2 describes the NDD sedimentation system that is designed to reduce sediment delivery through the dual conveyance system. It cites "normal settling depth and the design WSE depth that will enable sands and coarse silt materials (particle size between 1.75 mm and 0.075 mm) to settle in the basins". However, note that particle sizes 0.075-1.75 mm are usually considered to be all sand, not "coarse silt". Table 6.5 in that document provides estimates of sediment loading to each intake and Table 6.6, showing the river's actual sediment particle distribution, suggests that more than 61% will not settle in the basins. Thus, only about 40% of the sediment load captured by the NDD will be available for "recycling" back into the system, given the caveat that contaminant levels of the retained coarse materials would allow such reuse. Furthermore, the material that will be exported to the southern Delta through the PA's dual conveyance system will be the fine suspended sediments that provide the greatest benefits through accretion in tidal wetlands, to sustain elevation increases commensurate with sea level rise (Swanson et al. 2015), further starving the northern Delta tidal marsh habitat of juvenile Sacramento Winter-run Chinook Salmon, as well as turbidity, a key abiotic habitat characteristic for Delta Smelt."